Photograph from the cast of a statue of "Diskobolus," now in the Palazzo-Messini at Rome, with a model in approximately the same position as the statue. Compare Plates 100 and 101.

ANATOMY

In its Relation to Art

An exposition of the bones and muscles of the human body with especial reference to their influence upon its actions and external form

BY

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ILLUSTRATED BY THREE HUNDRED AND THIRTY-EIGHT ORIGINAL DRAWINGS AND PHOTOGRAPHS MADE BY THE AUTHOR AND EXPRESSLY PREPARED FOR THIS WORK

"Whatever excuse may be made for the Artist in not *teaching* Anatomy, there can be none offered for his not *learning* it."—From "Elements of Art," by M. A. Shee, R. A.

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This book is affectionately dedicated
to my wife

HARRIET HARE McCLELLAN

whose sympathy and encouragement have
made possible this adaptation
of anatomy to art.

PREFACE.

AN exhaustive knowledge of anatomy, such as may only be obtained in the dissecting-room, is not necessary for the art-student. It would little avail him to spend a long time in endeavoring to understand the minute and complicated relations of the ligaments and tendons, of internal organs and deep muscular structures, because scientific anatomical study, while not necessarily detrimental to artistic work, may mislead the artist. This is often painfully illustrated in modern sculpture, by an exaggerated representation of the anatomy which shows that the artist, with the intention of being realistic, has familiarized himself with the appearances of the dead body, and not drawn conclusions by comparison with living models. It is undoubtedly due to the greater perfection of living models as well as the more frequent opportunity for studying them that ancient sculpture is so excellent, and those who have approached nearest to the work of the great masters have understood that the real as well as the ideal form can be produced with truthfulness only after educated observation.

A general knowledge of anatomy is essential and may be intelligently acquired so that it will be of great assistance to the art-student, provided it is kept within the scope of its object, which should be its adaptation to the understanding and representation of actions or of form.

Anatomy for art purposes should never be obtrusive. It should be employed as a means of analysis and interpretation of motion and form, and thus used will serve to encourage keener powers of observation upon which excellence in representation so much depends.

In venturing to contribute another book to the long list of those which have preceded this, the author wishes to observe that too much stress has often been laid upon anatomical details, and as a result the tendency has been to exaggerate them upon canvas or in marble. There may be some art-students who are able to sift and discriminate among facts obtained by the most diligent and exact methods; but the generality of them are probably not unlike other students and are too prone to wish to exhibit all they know, so that they require some guidance in acquiring information and suggestion as to how best to use it.

The present work is based upon a system adopted in the course of lectures at the Pennsylvania Academy of the Fine Arts, where, as Professor of Anatomy for twelve years, the author has had especial experience of the needs of art-students. The descriptive matter relating to the bones and muscles is accurate although not exhaustive; but only those parts are explained which would seem worth dwelling upon for art application. The subtle complex changes of the form of the human body when in motion are most difficult to comprehend, and can only be explained through a knowledge of its structure.

In order to bring the subject within easy comprehension of all, whether familiar or not with scientific nomenclature, the text is rendered in clear and simple language, and all technical phraseology which could not be avoided is translated.

In no other department of study is there greater need for the mind to be educated through the eye, and therefore much time and thought have been expended upon the illustrations which are entirely original. They consist of photographs from selected specimens and models as well as drawings carefully made to the same scale. The advantage of the arrangement of the illustrations in groups for critical comparison is that the eye may become accustomed to seeing much which without it might escape attention, and the faculty of perception can be cultivated so that the judgment is broadened in its grasp of details. This is a quality to be encouraged in artists, especially in drawing

from the life, for often their copies, while not devoid of artistic merit, show a lack of thorough comprehension of what they *ought to see.* In attempting to direct the observation of students, however, it is not intended to teach them to see only what they are told to see or to see through the eyes of others. It is the object of this book to assist artists to see for themselves.

In attempting to illustrate with his own pencil, the author makes no pretension to enter the field of an artist, as it is only claimed that the drawings are diagrammatic expositions of the anatomy of the human body where photographs would not serve the purpose of bringing the subject to the comprehension of the student for whom it is designed. Of the work done with his camera he is more confident, and hopes that it may be as instructive to others as it has been interesting to him.

The admirable reproductions of the drawings and photographs are as nearly *fac-simile* of the author's originals as they could be, and for the faithfulness of these copies he is indebted to Mr. H. I. Thompson of the Photo-Chromotype Engraving Co., of Philadelphia. The printing of the text matter and illustrations has been in the hands of the Alfred M. Slocum Co. To these gentlemen the author expresses his grateful appreciation for their interest and painstaking care throughout the manufacture of the book.

George McClellan.

Broad and Spruce Streets,
Philadelphia, October, 1900.

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List of Illustrations.

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PLATE 16.

PLATE 17.

PLATE 18.

PLATE 19.

PLATE 20.

PLATE 21.

N. B.—The section in Fig. 2 is not through the brain, the outer surface of which is represented.

N. B.—The above are drawings from photographs.

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PLATE 53.

PLATE 54.

PLATE 55.

PLATE 56.

ANATOMY IN ITS RELATION TO ART.

THE object of this book is to contribute to that knowledge of human anatomy with which artists are chiefly concerned, and it should therefore be understood, as preliminary to so complex a subject, that the deeper structures are here set forth solely for the purpose of explaining their influence upon the *surface anatomy*.

The skin is a sensitive protective covering which is peculiarly adapted to the requirements of the several regions of which the body is composed, and an account of it is given after the description of each of the parts with which it is identified.

Beneath the skin is another covering, the *subcutaneous fascia*, consisting of a loose layer of areolar, or connective tissue, in which the *fat* is lodged, and in health accumulates in certain localities more than in others. As the fat somewhat masks the subjacent parts, it is also described with the skin.

Beneath the subcutaneous fascia there is a layer of *deep fascia*, destitute of fat, which closely invests the muscles and organs, firmly holding them in position, and from which leaflets are separated to surround the various structures, thereby forming for them enveloping sheaths. In the case of the muscles this arrangement greatly increases their power.

The muscle tissue is composed of fibres aggregated in bundles, each fibre and each bundle having a sheath derived from the deep fascia. At either end of the muscle the sheath becomes condensed into *tendons* which are attached to the contiguous bones. The fixed end of a muscle is called its origin, while the

end which produces movement is called its insertion. The muscles are variable in the disposition of their fibres according to their functions and the rôle which they are designed to perform. Both the bones and muscles are normally disposed so that they are symmetrical on the two sides of the body. The muscles constitute the *flesh* of the body. They are the active organs of movement. The bones which form the skeleton or framework are the passive organs which are acted upon by the muscles. The movements are either voluntary or involuntary, and are dependent upon the influences acting through the nervous system. Muscles may act from either end and in opposite directions according to the stimulus which they receive.

During life when the brain and nerve centres are awake to the impressions of exciting influences the circulation of the blood increases throughout all the tissues of the body and then the muscles are capable of energy. It is only during profound sleep that they are relaxed and quiescent. After death they become shrunken and often rigid (*rigor mortis*), due to a peculiar chemical change in their composition.

In order to avoid the mistake of studying the parts separately considered as distinct organisms it should always be remembered that as parts they are only adjuncts to the wonderful machinery of the body, which owes its life, its growth, its power and beauty to the exercise of the functions of the nerves, blood-vessels, digestive apparatus and special organs which control them. An account of these important organs belongs to another sphere of the study of anatomy, and is outside of the present task, but from the nature of things they must from time to time be referred to, and experience has shown that there is no better way of encouraging *observation*, an essential faculty for artists, than by emphasizing the relations which they bear to the actions of the body.

The art-student of anatomy should always keep in mind that the human body is *designed to be supported erect*. It consists of the head, neck and trunk, and two pairs of extremities, the upper and lower limbs.

THE SKELETON.

EVERY bone of the skeleton after death bears individual features which indicate, in a measure, the wear-and-tear it has been subjected to during life, and from them whole histories might be deduced. It would be beside the object of this book to enter into a minute description of the several bones, for artists are not, and never need be, scientific anatomists; they have enough weary details to digest without taxing their power of assimilation by particularizing points, which, however interesting, are beside the mark. The entire skeleton should be studied with its component bones in proper relation; but, in order to comprehend the purpose of its construction, it is well to observe separately those bones which especially influence the external form, in whole or in part, in the different regions of the body.

The bones cannot be well learned from diagrams, and whenever possible the real specimens should be examined. As these are seldom within reach of the student, both drawings and photographs, from selected specimens, are here used as illustrations; the latter, being accurate, are of special service in producing a realistic impression. The sculptor, especially, should be acquainted with the articulated skeleton placed in various positions so that he may comprehend the elevations and depressions it presents in contrast to those which are found when it is covered with flesh and clothed with garments. Comparison of the skeleton with the living model will show that much of the outward form is dependent upon the framework. (Plates 1, 2, 3, 4, 5 and 6.)

Some parts of the skeleton are always conspicuous, being covered merely by the skin, and may be referred to as *landmarks*. They are useful as points of reference; of these the most valuable are the prominences of the skull, the spine of the seventh vertebra in the neck, the spines of the shoulder-blades, the collar-bones, the ridge between the first and second pieces of the breast-bone, the prominences of the shoulder, the elbow, the wrist and the hand, the prominences of the pelvis, the hip, the ankle and the foot.

In those parts of the body which are covered with much flesh it is

noticeable that there are depressions and hollows in the skeleton upon both sides, as between the ribs and the spinal column.

There are about two hundred bones in the human skeleton. They are classified as *flat, long, thick* and *irregular* bones. *Flat bones* are always found where protection is necessary to contained organs, as in the head, the thorax, and the pelvis. *Long bones* are in the extremities, where they serve as levers, and are adapted to the actions of muscles in the various movements, and in support. *Thick bones* are in the wrist and ankle, where strength and freedom of motion are necessary. *Irregular bones* are in the spinal column, where the several vertebræ present thick portions in front, being super-imposed so as to support the weight of the head and trunk, while behind, the segments are composed of flat parts for protection to the spinal cord. During life the bones are not as they appear in the dried skeleton; they are then living structures, and have a certain amount of elasticity depending partly upon their organization and partly upon their conformation. The construction of each individual bone defies improvement for its purpose. They are smooth where the parts surrounding them are not attached, and always roughened where the tendons are inserted; they are not unnecessarily solid or heavy; the outer surface is denser and harder than the interior, which is channeled for blood-vessels, and in the long bones there is a hollow space which extends within the shaft, or body, toward either extremity. This space is filled with *marrow* while the bone is living; otherwise, were the bone solid, it would be very heavy and unwieldy. A skeleton is called *natural* when its component bones are held together by ligaments, and *artificial* when the bones are connected by wires.

PLATE 1.

Fig. 1. Photograph of a man aged 24 years; height, 5 feet 8 inches; weight, 145 pounds (*from the front*).

Fig. 2. Photograph of the same man as in Fig. 1 (*left side*).

N. B.—This man possesses a form rarely suitable for artistic study, both as to symmetry of development and proportion. Compare Plates 90, 92, 94, 99, 103 and 110.

Plate 118 shows his stature to be equal to eight times the length of his head, and as his head measures eight and one-half inches, his height is exactly sixty-eight inches or five feet eight inches.

The measurement from the top of his head to the soles of his feet, when he is standing, is the same as the measurement from the finger-tips of one hand to those of the other when his arms are equally extended on either side. (See Plate 117 and page 130).

PLATE I

Fig. 1

Fig. 2

PLATE 2.

Fig. 1. Photograph of the skeleton, with outline, of a man aged 37 years; height, 6 feet 1 inch (*from the front*).

Fig. 2. Photograph of the skeleton, with outline, of a man (same as Fig. 1) (*left side*).

N. B.—This skeleton is remarkable for the perfect development of every bone composing it. It should be noted that the height is due to the unusual length of the lower extremities, in which, as well as in the upper extremities, the bones are relatively longer than they are ordinarily.

PLATE 2

Fig. 1

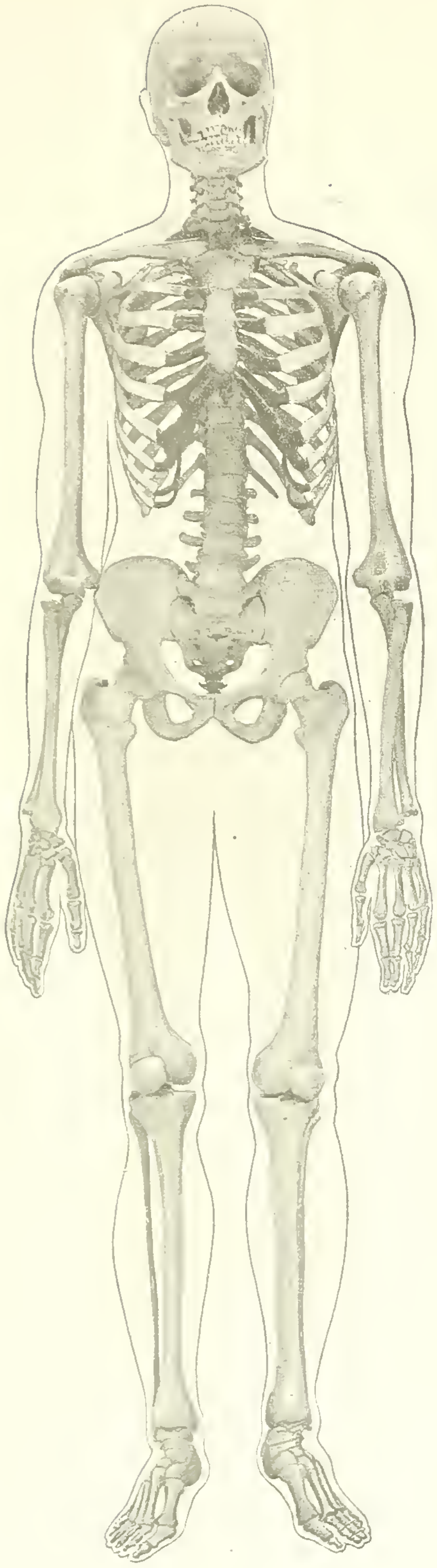


Fig. 2

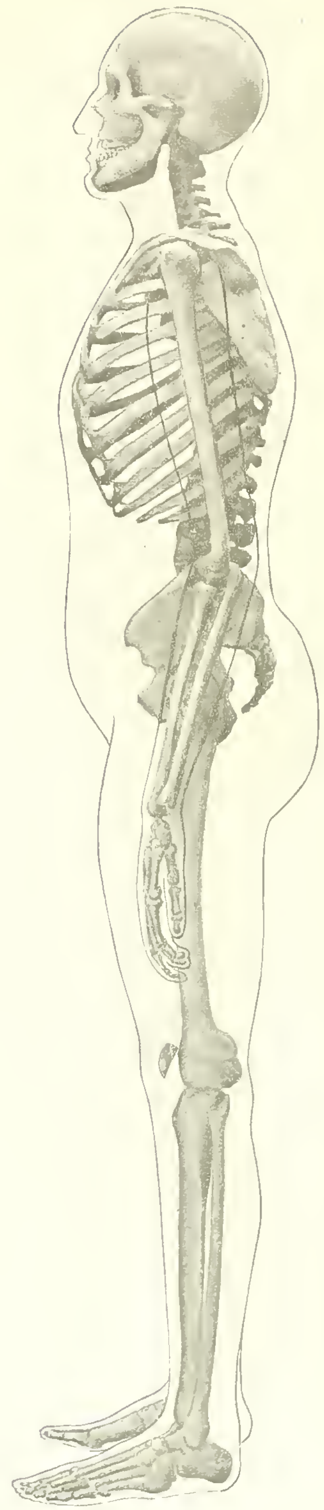


PLATE 3.

Fig. 1. Photograph of a woman aged 23 years; height, 5 feet 4½ inches (*from the front*).

Fig. 2. Photograph of a woman (*left side*).

N. B.—The model was especially selected for graceful proportion, but an incomplete development of the breasts gives the appearance of greater youth in profile. Compare Plates 75, 76, 77, 82, 83, 84 and 85.

Plate 119 shows this woman's stature to be seven and one-half times the length of her head. (See page 130.)

PLATE 4.

Fig. 1. Photograph of the skeleton of a woman, with outline; height, 5 feet 4½ inches (*from the front*).

Fig. 2. Photograph of the skeleton of a woman, with outline (same as in Fig. 1) (*left side*).

N. B.—As this skeleton is equal in height to that of the woman shown in Plate 3 a comparison of the two plates will be instructive.

PLATE 4

Fig. 1

Fig. 2

PLATE 5.

Fig. 1. Photograph of the back of a man (same as in Plate 1).

Fig. 2. Photograph of the back of a woman (same as in Plate 3).

N. B.—This plate should be studied in comparison with the following Plate 6; also with Plates 118, 119 and 120.

PLATE 5

Fig. 1

Fig. 2

PLATE 6.

Fig. 1. Photograph of the skeleton of a man, with outline, (same as in Plate 2) (*from the back*).

Fig. 2. Photograph of the skeleton of a woman, with outline, (same as in Plate 4) (*from the back*).

PLATE 6

Fig. 1

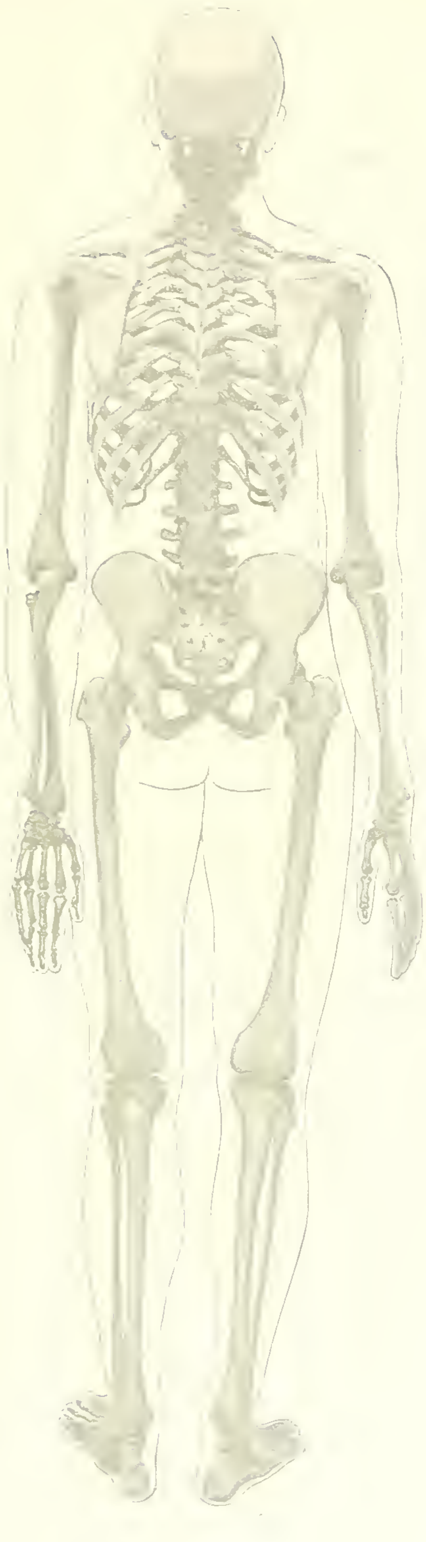


Fig. 2

THE ARTICULATIONS.

THE *joints or articulations* are where the separate bones of the skeleton are fastened together, and the parts of the bones which enter into them are peculiarly adapted to the various movements of the body.

There are three kinds of joints: *immovable* or *fixed* joints, as at the borders of the bones of the head; *mixed* joints, where the motion is slight, as between any of the segments of the spinal column, the wrist, and the ankle; and *movable* joints, which are found especially where the long bones act upon one another, as in the extremities.

To the artist the movable joints are of the greatest interest, and particular attention should be given to all the parts which are in relation to them, because they distinctly affect the outward form. The surfaces of the ends of the bones entering into the movable joints are very hard and smooth, and in the natural state are covered with cartilage, or gristle, which is usually thickest at the point where the greatest pressure is exerted. The ends are enclosed within a membranous *capsule,* the internal surface of which has the property of secreting a peculiar fluid, the *synovial* (resembling the white of an egg) or *joint juice,* which lubricates the parts and enables them to be freely moved without being subjected to friction. The joints are strengthened by *ligaments,* which are dense bands of fibrous tissue. The articular surfaces are more or less kept in apposition by the action of the muscles, through the disposition of the tendons which pass over them, and by atmospheric pressure.

The joints of the extremities deserve special attention.

The *shoulder-joint* (Plate 7, Figs. 1, 2, and 3) is like a ball and socket, capable of universal motion, enabling the upper extremity to be moved about the trunk in all directions. In order to effect this the upper end of the arm-bone (humerus) is nearly spherical in shape, and the cupped depression upon the shoulder-blade against which it rests is very shallow. The capsule of this joint is very loose, and there are no marked constraining ligaments, so that when the upper extremity hangs freely beside the trunk, there is more or less separation of the head of the arm-bone from the shoulder-blade. In thin persons there is a noticeable

depression at this locality, and it may be felt in all persons through the overlying (deltoid) muscle. When the shoulder-joint is in action it is mainly strengthened by the tendons of the biceps muscle, which are disposed so that they preserve the relation of the head of the arm-bone to the shallow depression on the shoulder-blade, and at the same time prevent a too great separation or dislocation (Plate 43, Fig. 1). (See page 74.)

At the elbow the joint (Plate 8, Figs. 1, 2, 3, 4, 5 and 6) is essentially a hinge, the bones entering into its formation being so adapted that they can only be moved in flexion and extension. The *elbow-joint* consists of the lower end of the arm-bone and the upper end of one of the bones of the fore-arm (the ulna), held together by lateral ligaments. The upper end of the other fore-arm bone (the radius), although it is present at the elbow, does not play any part in its function. (See page 71.)

The hand is attached at the *wrist-joint* (Plate 9, Figs. 5 and 6) to the lower end of the radius, and as the upper end of that bone (radius) is held by a special circular ligament to the upper end of the ulna, below the elbow, it is enabled to follow the motions of extension and flexion at that joint, and at the same time be turned over backward (supinated) or forward (pronated) through the actions of the muscles upon the radius, which can be twisted around the ulna (Plates 47 and 48.) This is one of the wonderful mechanical arrangements which provides an instance of the best possible means toward an useful end to which the construction of the body bears witness from whatever point of view it is studied. The lower end of the ulna is hardly any more a feature of the wrist-joint than is the upper end of the radius of the elbow. It is attached to the hand by a loose ligament. Between the companion bones of the fore-arm there is a strong *interosseus membrane* which, being attached to their inner borders, serves to check rotation of the radius carrying the hand with it, in supination or pronation. In consequence of this arrangement, the wrist-joint is capable of flexion and extension and of circumduction to a limited degree. (The movements of the thumb and fingers are described with the hand, pages 80 to 86.)

The joints of the upper extremity considered together show an inter-dependence which serves the purpose of *prehension*, and on occasion renders an important means of defense. The harmony of action of the several joints at the fingers, the wrist, the elbow, and the shoulder, is best appreciated by noticing the

ordinary uses to which the limb is applied, as in dressing, in feeding, in playing the violin, throwing a stone, etc. Any impairment of one or other of the joints interferes with the functional use of the others, and this is greatest when the trouble occurs at the shoulder.

The joints of the lower extremities correspond to the joints of the upper extremities, but are modified for *support* whether the body be at rest or in action.

The hip-joint (Plate 7, Figs. 4, 5 and 6) approaches in character that of the shoulder; the head of the thigh-bone (femur) is even more spherical than the head of the arm-bone, but the depression in the haunch-bone (ilium) is not shallow, being so deep that it almost completely contains the head of the thigh in all positions. At the hip the capsule is not loose, and there are strong ligaments as well as powerful tendons which, both at rest and in motion, serve to keep the bones properly adjusted to carry the weight of the trunk. The movements at the hip joint are in all directions, but without the freedom as are those at the shoulder.

The knee-joint (Plate 8, Figs. 7, 8, 9 and 10, and Plate 9, Figs. 1, 2, 3 and 4) is composed of the lower end of the thigh-bone and the upper end of the shin-bone (tibia), and when the skeleton is examined appears to be very weakly constructed, for the bones are merely in contact with one another, not mortised, or presenting a depression in the one for reception of a projection from the other, as in the analogous joint of the upper extremity. Like the elbow, however, the knee has mainly a hinge motion, for extension and flexion. There are strong ligaments at the sides of the knee, and a synovial membrane which is peculiarly folded so as to furnish a large secreting surface for the synovia upon the ends of the bones. In front there is a separate bone, the *knee-pan* (patella), which serves to protect the joint in kneeling, and as a pulley for the tendons of the great muscles which extend the leg upon the thigh. The tendons of the various muscles which pass over this joint hold the bones together with remarkable security, so that in spite of the apparent weakness in the skeleton it is really one of the strongest joints in the body. Between the two bones of the leg, as in the arm, there is an *interosseous membrane* which, however, merely affords a greater surface for the attachment of the leg muscles, as there is very little motion between the tibia and the fibula, which are held together above and below by strong ligaments.

The ankle-joint (Plate 9, Figs. 7 and 8) is a mortise-joint, and is formed by the lower ends of the two leg-bones (the tibia on the inner side and the fibula on the outer) which receive between them the upper bone of the foot (astragalus). The outer ankle-bone is always lower than the inner, thus preventing the movement of the foot outward, which is its natural disposition, to the same extent as it can be moved inward. The motions at the ankle are extension, flexion and lateral, adapting it to the uses of the foot in standing, walking running, leaping, dancing, etc. (The movements of the joints of the toes are described with the foot, pages 109 and 110.)

The artist should observe the joints in the living model and compare them with the skeleton; they should also be examined carefully in arrested motion, for much can be learned in this way which it is impossible to describe.

PLATE 7.

Fig. 1. The bones of the right shoulder joint (*from the front*).

1. The clavicle.
2. The acromion process of the scapula.
3. The coracoid process of the scapula.
4. The glenoid fossa of the scapula.
5. The head of the humerus.
6. The outer tuberosity of the humerus.
7. The bicipital groove of the humerus.
8. The anterior tuberosity of the humerus.
9. The rhomboid ligament, connecting the clavicle with the top of the sternum.

Fig. 2. The ligaments of the right shoulder joint (*from the front*).

1. The acromio-clavicular ligament.
2. The coraco-clavicular ligament.
3. The capsular ligament.
4. The long tendon of the biceps muscle.

Fig. 3. The ligaments of the right shoulder joint (*from the back*).

1. The acromio-clavicular ligament.
2. The capsular ligament.

Fig. 4. The right hip joint (*from the back*).

1. The capsular ligament.

Fig. 5. The bones of the right hip joint (*from the front*).

1. The innominate bone.
2. The acetabulum.
3. The ligamentum teres.
4. The great trochanter of the femur.
5. The head of the femur.
6. The lesser trochanter of the femur.

Fig. 6. The right hip joint (*from the front*).

1. The capsular ligament.
2. The ilio-femoral or Y-shaped ligament.

PLATE 7

PLATE 8.

Fig. 1. The bones of the left elbow joint in extension (*from the front*).

1. The inner condyle of the humerus.
2. The trochlear surface of the humerus.
3. The coronoid process of the ulna.
4. The outer condyle of the humerus.
5. The head of the radius.
6. The bicipital tubercle of the radius.

Fig. 2. The ligaments of the left elbow joint (*from the front*).

1. The capsular ligament.
2. The orbicular ligament.
3. The superior radio-ulnar ligament.

Fig. 3. The bones of the left elbow joint in extension (*from the back*).

1. The outer condyle of the humerus.
2. The upper end of the ulna.
3. The head of the radius.
4. The bicipital tubercle of the radius.
5. The inner condyle of the humerus.
6. The olecranon process of the ulna.

Fig. 4. The ligaments of the left elbow joint (*from the back*).

1. The capsular ligament.
2. The orbicular ligament

Fig. 5. The bones of the left elbow joint flexed at a right angle (*from the outer side*).

1. The lower end of the humerus.
2. The head of the radius.
3. The bicipital tubercle of the radius.
4. The outer condyle of the humerus.
5. The sigmoid cavity of the upper end of the ulna.
6. The olecranon process of the ulna.

Fig. 6. The ligaments connecting the bones of the left elbow joint in same position as Fig. 5.

1. The orbicular ligament.
2. The capsular ligament.

Fig. 7. The bones of the right knee joint in extension (*from the front*).

1. The outer condyle of the femur.
2. The patella.
3. The outer tuberosity of the tibia.
4. The head of the fibula.
5. The inner condyle of the femur.
6. The inner tuberosity of the tibia.
7. The tubercle of the tibia.

Fig. 8. The ligaments of the right knee joint (*from the front*).

1. The cut end of the ligamentum patellæ.
2. The patella.
3. The head of the fibula.
4. The capsular ligament.
5. The tubercle of the tibia.
6. The insertion of the ligamentum patellæ.

Fig. 9. The bones of the right knee joint in extension (*from the back*).

1. The inner condyle of the femur.
2. The inner tuberosity of the tibia.
3. The outer condyle of the femur.
4. The outer tuberosity of the tibia.
5. The head of the fibula.

Fig. 10. The ligaments of the right knee joint (*from the back*).

1. The capsular ligament.
2. The superior tibio-fibular ligament.
3. The first external lateral ligament.
4. The second external ligament.

PLATE 8

Fig. 1.

Fig. 2.

Fig. 3.

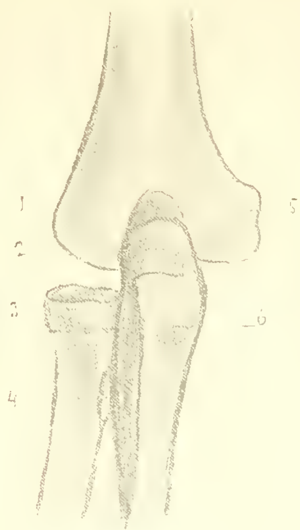


Fig. 4.

Fig. 5.

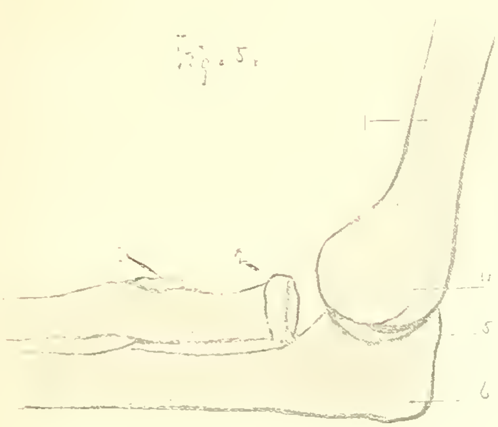


Fig. 6.

Fig. 7

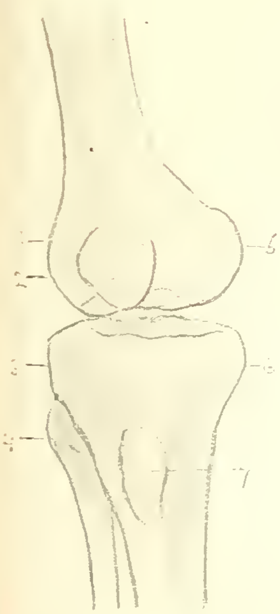


Fig. 8.

Fig. 9.

Fig. 10.

PLATE 9.

Fig. 1. The bones of the right knee joint, in extension (*from the outer side*).

Fig. 2. The bones of the right knee joint, in extension (*from the inner side*).

Fig. 3. The bones of the right knee joint flexed at a right angle (*from the outer side*).

Fig. 4. The bones of the right knee joint flexed at a right angle (*from the inner side*).

Fig. 5. The skeleton of the right wrist and hand, showing the ligaments upon the palmar surface.

Fig. 6. The skeleton of the right wrist and hand, showing the ligaments upon the dorsal surface.

Fig. 7. The bones, with the ligaments, of the right ankle joint (*from the outer side*).

Fig. 8. The bones, with the ligaments, of the right ankle joint (*from the inner side*).

Fig. 1.

Fig. 2

Fig. 3.

Fig. 4.

Fig. 5.

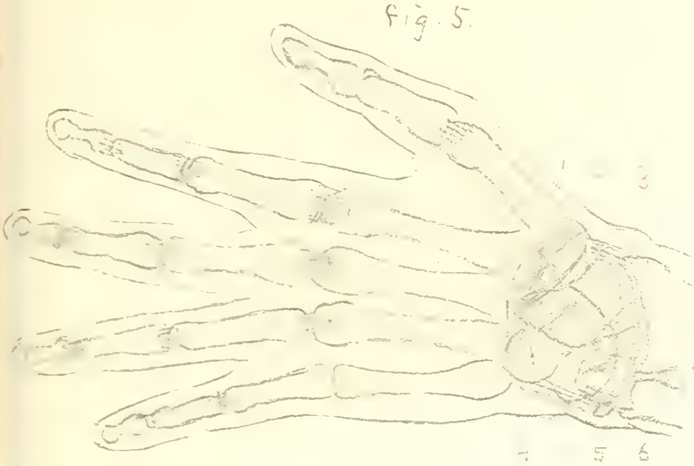


Fig. 6.

Fig. 7.

Fig. 8.

THE BONES OF THE HEAD AND FACE.

THE *skull*, or framework of the head, consists of the cranium and the bones of the face. In infancy the *cranium* is composed of eight separate bones: the frontal, the right and left parietal, the right and left temporal, the occipital, the sphenoid and the ethmoid. In childhood they become joined at their borders by peculiar dovetailed indentations, *the sutures,* and throughout life form the solid, bony, egg-shaped box or brain-case, which, in all the variations of size and shape, contributes to the surface form of the head. After puberty certain prominences become more or less developed and thus influence the character of the individual head.

The frontal bone (Plate 10, Figs. 1 and 2) forms the forehead. It is smooth and subcutaneous, the frontal portion of the scalp muscle (page 31) being extremely thin, so that the shape of the bone is always distinctive.

The noteworthy features are the prominences on either side of the forehead, the *frontal eminences* which indicate the development of the forepart of the brain; the *ridges* over the eye-sockets which support the eye-brows, the *outer angles* of the eye-sockets, which give breadth to the upper part of the face, and the *spine*, upon which rest the bones of the nose. The ridges (Plate 10, Figs. 1 and 2) are caused by the formation of a cavity, the *frontal sinus*, owing to the separation of the tables of the frontal bone at this part at maturity (Plate 13, Fig. 6). The cavity is connected with others in the ethmoid and sphenoid bones, and contributes to the resonance of the voice. The frontal sinus is always larger in the male, and the degree of prominence of the frontal ridges gives proportionate force to a manly face. In babyhood the frontal bone (Plate 14, Fig. 4) consists of two halves which unite at about the second year.

The *parietal bones* (Plate 10, Figs. 4 and 5) together form the sides and vault of the cranium. Their development is commensurate with the lateral expansion of the brain (cerebrum). The ridges on the sides afford attachment to the corresponding temporal muscles and their sheaths (page 42).

The *temporal bones* (Plate 10, Fig. 7) are placed at the lower parts of the sides of the skull, and extend toward one another at its base (Plate 13, Fig. 5). They are peculiarly shaped and constructed in their several portions. At the sides, where they articulate with the parietal bones, they have no sutures, but overlap with the corresponding lower borders of these bones. The portions which project inwardly are very strong and hard and are excavated for the delicate organs of hearing which they contain. The large opening on the outer side is the passage-way (Plate 10) by which the vibrations of the air which produce sound are conveyed to the ear-drum, after they are collected by the external cartilaginous projection called the auricle (Plate 16). The long, slender portion of the temporal bone which extends forward to receive the bone of the cheek, forms *the zygoma* (or yoke) beneath which the temporal muscle passes to be inserted into the branch of the lower jaw (Plate 16). The prominence of bone readily felt behind the ear is called the *mastoid process* because it resembles in shape a teat or nipple. The sterno-mastoid muscle of the neck is attached to it. (Page 47.)

The *occipital bone* (Plate 10, Figs. 3 and 6) is at the back and under part of the cranium, joined to the parietal bones above and to the temporal bones below. Its chief feature is the *external prominence* at its middle, where the bone is thickest and can be easily felt through the scalp. The *curved lines* on either side afford attachment to the muscles which hold the head erect. The *condyles* are the portions of the bone which rest upon the topmost vertebra of the spinal column (Plate 10, and page 43).

The *sphenoid* and *ethmoid bones* are in the base of the skull. The sphenoid (wedge-shaped) bone is really the irregular forward prolongation of the occipital bone (Plate 10, Figs. 11 and 12). These bones serve to connect the bones of the face with those of the cranium.

The skeleton of the face consists of twelve bones. Most of them are so covered by the soft structures, or so remotely situated, that only those which directly influence the surface are particularly referred to in this connection.

The *nasal bones* (Plate 11, Figs. 1, 2, 3 and 4) are two elongated quadrilateral-shaped little bones which project from the upper part of the face between the orbits, resting upon one another in the middle line forming the "*bridge*" of the nose, and connected to the spine of the frontal bone above. The bridge is always remarkably strong. Upon the lower borders is supported the cartilaginous framework, which is composed of five peculiarly shaped movable cartilages (Plate 12, Figs. 1, 2 and 3). The nasal bones vary in width and length in different skulls, and, as they are merely covered by the skin, they give shape to the organ. These small bones offer great interest to the student of physiognomy because they are rarely exactly arranged the same in any two heads. The slightest depression or elevation at their junction with the frontal bone will occasion a change in the outward character of the nose as seen in profile (Plate 11, Figs. 1, 2 and 3). Upon the sides, the nasal bones rest against the upward prolongations of the corresponding upper jaw-bones, so that the breadth of the nose is due to this relation. The flattened form in the African is a marked illustration.

The nasal cartilages (Plate 12, Figs. 1, 2 and 3) consist of an upper triangular and a lower oval piece on each side, which together give shape to the wings and tip of the nose. In the middle there is a cartilaginous plate *(the septum)*, which separates the nostrils. When the lower lateral cartilages are not in contact there is a more or less marked depression at the tip of the nose. The elasticity of these cartilages enables the muscles (Plate 15) moving them to expand or contract the orifices so important in respiration (page 39).

The vomer (*ploughshare*) (Plate 13, Fig. 1) is the bony partition between the nostrils. It is inclined to one side or other, usually the left, and as it supports the septal cartilage, the nose is not often straight in the middle of the face.

The upper jaw-bones (Plate 11, Figs. 5 and 6) form the right and left walls of the face, and are hollowed into the nasal chambers. Laterally the upper jaws support the *cheek bones* (Plate 11, Figs. 7 and 8), which should be attentively studied by the artist, because they are the most distinctive of the face when

viewed from the front. Whether the cheeks be high or low depends upon the development of the cheek bones, and their manner of articulation with the contiguous temporal, frontal and upper jaw-bones (Plate 11, Figs. 1, 2 and 3).

The lower jaw-bone (Plate 11, Figs. 1, 2, 3 and 6) gives force and strength to the face in proportion to the pronounced development of its several parts. It presents a horse-shoe shaped portion, the *body*, from the sides of which a *branch* (ramus) extends upward on either side. The angles formed by the branches with the body vary according to the age of the person, being obtuse in infancy, approaching a right angle in the adult, and returning to the infantile form in extreme old age (Plate 10, Figs. 8, 9 and 10). This is mainly due to the absence, development and loss of the teeth at these periods of life (Plate 14). The angles of the adult lower jaw are more or less prominent and not as symmetrical as the other bony features of the human face. In early life this bone consists of two separate halves, which join in the middle, forming the chin (Plate 14, Fig. 4).

It should be noted that when the lower jaw is square it gives a coarseness and heaviness to the face, and that the angle is never at a right angle in a well-shaped head in either sex or at any age.

The entire skull (Plates 13, 14) should be carefully studied after understanding the component bones. When looked at from in front or from behind or from above, the shape of the head will be found to depend upon the degree of development of the various prominences. The breadth of the head is due to the lateral outward projection of the parietal eminences; the breadth of the face to the lateral outward projection of the external angular processes of the orbits, the cheek bones and the angles of the lower jaw. When the skull is viewed in profile, much of the character of the head and face is commensurate with the height of the frontal bone, the depth of the jaw, and the forward projection of the ridges for the eyebrows, the attachment of the nasal bones and the prominence of the chin.

Comparison of the skulls of an adult and of an infant shows that the difference exists in the relative proportions of the head and face (Plate 14).

Throughout childhood this gradually diminishes. The changes which occur are chiefly in the development of the teeth and the jaws which contain them. In the various stages of youth to manhood there are peculiarities of form of the head and face which are contemporaneous with the development of the power of speech.

The so-called *facial angle* (Plate 14, Figs. 1, 2 and 3) is formed by the degree of divergence (*E. F.*) of a line (*C. D.*) drawn from the forehead to the sockets of the incisor teeth, intersecting a horizontal line (*A. B.*) drawn from the latter point to the occiput through the auditory opening. Comparison of the angle as measured on the skulls of the European, and the African, and the ourang-outang, demonstrates that it is greatest in the white man, and that it diminishes in the negro, and in the ape becomes acute.

The skulls of different races of mankind show this different degree of the facial angle somewhat in proportion to the degree of their intelligence, but it is by no means to be relied upon. For art uses, the more nearly the facial angle approaches a right angle the more it has been held to be related to beauty of proportion. The old Greek and Roman sculptors made much of this in idealizing their work, but the subtle elements which constitute what is usually called beauty cannot be measured by the degree of the facial angle any more than can the intellectual capacity be gauged by it. They equally depend upon the quality and not the quantity of the relative areas of the face and brain-case.

PLATE 10.

Fig. 1. The frontal bone.

1. The right frontal eminence.
2. The right superciliary ridge.
3. The external angular process of the right orbit.
4. The spine for the nasal bones.
5. The left frontal eminence.
6. The left superciliary ridge.
7. The external angular process of the left orbit.

Fig. 2. The frontal bone (*left side*).

1. The frontal eminence.
2. The superciliary ridge.
3. The nasal spine.
4. The external angular process of the orbit.

Fig. 3. The occipital bone.

1. The external protuberance.
2. The superior curved line.
3. The inferior curved line.
4. The foramen magnum.
5. The left condyle.
6. The basilar process.
7. The right condyle.

Fig. 4. The left parietal bone.

1. The frontal border.
2. The superior curved line.
3. The inferior curved line.
4. The temporal border.
5. The eminence.
6. The occipital border.

Fig. 5. The two parietal bones united.

1. The inner parietal or sagittal suture.
2. The right eminence.

Fig. 6. The occipital bone (*left side*).

1. The basilar process.
2. The condyle.
3. The temporal border.
4. The external protuberance.

Fig. 7. The left temporal bone.

1. The zygomatic process.
2. The external auditory opening.
3. The styloid process.
4. The mastoid process.
5. The parietal border.

Fig. 8. The lower jaw-bone of an infant at birth.

Fig. 9. The lower jaw-bone of an adult.

Fig. 10. The lower jaw-bone of an aged person.

Fig. 11. The sphenoid bone (*from the front*).

1. The greater wing.
2. The lesser wing.
3. The cavity or sinus.
4. The rostrum.
5. The external pterygoid process.
6. The internal pterygoid process.
7. The greater wing.
8. The lesser wing.
9. The orbital plate.
10. The external pterygoid process.
11. The internal pterygoid process.

Fig. 12. The sphenoid and occipital bones united.

1. The greater wing of the sphenoid bone.
2. The left condyle of the occipital bone.
3. The occipital bone.

PLATE 10

PLATE 11.

Fig. 1. The bones of an European face, with outline (*left side*) showing the relation of the nasal bones which contribute to the Grecian profile.

Fig. 2. The bones of an European face, with outline (*left side*) showing the relation of the nasal bones which contribute to the Roman profile.

Fig. 3. The bones of an African face, with outline (*left side*) showing the relation of the nasal bones.

Fig. 4. The left nasal bone.

Fig. 5. The left upper jaw.

1. The nasal process.
2. The incisor teeth.
3. The canine tooth.
4. The bicuspid teeth.
5. The molar teeth.
6. The orbital border.
7. The sinus, or antrum of Highmore.

Fig. 6. The upper and lower jaw-bones in apposition (*from the front*).

1. The right nasal process.
2. The malar process.
3. The angle of the lower jaw.
4. The chin.
5. The nasal process of the left upper jaw-bone.
6. The malar process.
7. The intermaxillary suture.
8. The angle of the lower jaw.

Fig. 7. The left malar or cheek-bone (*from the side*).

1. The orbital border.
2. The maxillary border.
3. The external angular process of the orbit.
4. The zygomatic process.

Fig. 8. The right malar or cheek-bone (*from the side*).

1. The external angular process of the orbit.
2. The zygomatic process.
3. The maxillary border.

Fig. 9. The first cervical or Atlas vertebra (*from above*).

1. The anterior tubercle.
2. The left transverse process.
3. The spinal foramen.
4. The spinous process.
5. The transverse process.
6. The position of the cheek ligaments.

Fig. 10. The second cervical vertebra.

1. The odontoid process.
2. The condyloid process.
3. The body.
4. The bifid spine.

Fig. 11. The second cervical vertebra (*right side*).

1. The odontoid process.
2. The spine.
3. The condyloid process.
4. The body.

Fig. 12. The seventh cervical vertebra, or vertebra prominens.

1. The body.
2. The transverse process.
3. The spinous process.

Fig. 13. A thoracic vertebra.

1. The superior articulating process.
2. The facet for articulation of rib.
3. The spinous process.
4. Demi-facet for rib.
5. The body.
6. Demi-facet for rib.

Fig. 14. A lumbar vertebra.

1. The superior articulating process.
2. The transverse process.
3. The spine.
4. The inferior articulating process.
5. The body.

PLATE 11

PLATE 12.

Fig. 1. Diagram showing the nasal cartilages in relation to the bones of the face (*from the front*).

1. The junction of the right nasal bone with the frontal.
2. The right nasal bone.
3. The upper angle of the right upper lateral nasal cartilage.
4. The right lower lateral nasal cartilages.
5. The right nasal sesamoid cartilages.
6. The tip of the nose.
7. The left nasal bone.
8. The left upper lateral nasal cartilage.
9. The left lower lateral nasal cartilage.
10. The left nasal sesamoid cartilages.

Fig. 2. The nasal cartilages in relation to the bones of the face (*from the left side*).

1. The nasal bone.
2. The nasal process of the superior maxillary bone.
3. The upper lateral nasal cartilage.
4. The lower lateral nasal cartilage.
5. The nasal sesamoid cartilages.

Fig. 3. The nasal cartilages (*from below*).

1. The tip of the nose.
2. The right lower lateral nasal cartilage.
3. The inner fold of the lower lateral nasal cartilage.
4. The right sesamoid cartilages.
5. The septal cartilage.
6. The left lower lateral nasal cartilage.
7. The inner fold of the lower lateral nasal cartilage.
8. The left sesamoid cartilages.

Fig. 4. Diagram showing, on the right side, the muscles of the eye-ball; on the left, the elevator muscle of the upper eye-lid.

1. The right superciliary ridge.
2. The superior rectus muscle.

Fig. 4.—continued.

3. The superior oblique muscle.
4. The external rectus muscle.
5. The internal rectus muscle.
6. The inferior rectus muscle.
7. The inferior oblique muscle.
8. The left eyebrow.
9. The levator palpebræ superiorus muscle.
10. The upper eyelid.
11. The pupil.
12. The iris.
13. The lower eyelid.

Fig. 5. Diagram showing the muscles of the left eyeball (*from the side*).

1. The sinus of the frontal bone.
2. The elevator muscle of the upper lid.
3. The superior rectus muscle.
4. The external rectus muscle.
5. The inferior oblique muscle.
6. The inferior rectus muscle.
7. The cavity of the upper jaw-bone (antrum of Highmore).

Fig. 6. Diagram showing the left eye (*from the side*).

1. The upper eyelid.
2. The cornea.
3. The pupil.
4. The sclerotic coat.
5. The lower eyelid.

Fig. 7. Diagram showing the left eye, with fold of the skin over the upper eyelid (*from the front*).

1. The eyebrow.
2. The fold of the skin.
3. The upper eyelid.
4. The iris.
5. The elevation (caruncle) of the tear duct.
6. The lower eyelid.

PLATE 12

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

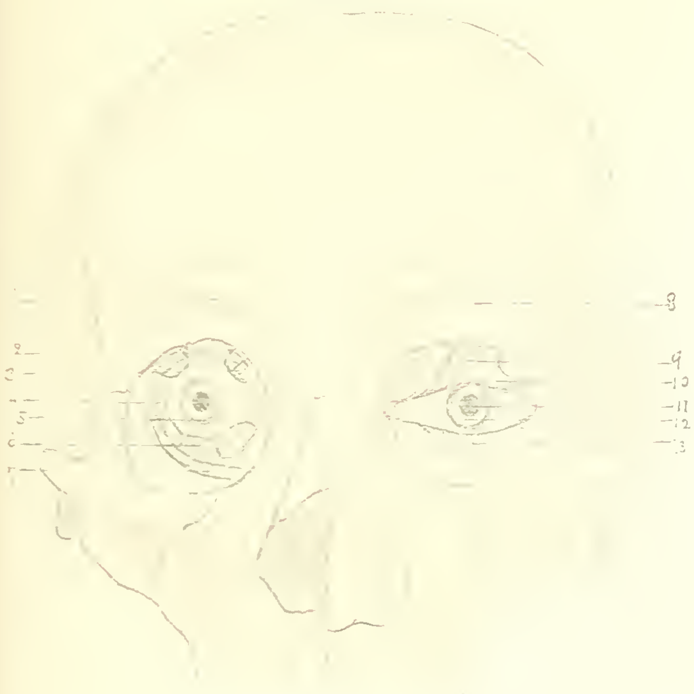


Fig. 5.

Fig. 7.

PLATE 13.

Fig. 1. Photograph of the skull of an European male, aged 33 years (*from the front*).

1. The right superciliary ridge.
2. The external angular process of the right orbit.
3. The right temporal bone.
4. The right malar bone.
5. The inter-maxillary suture.
6. The right mastoid process.
7. The angle of the lower jaw.
8. The prominence of the chin.
9. The suture between the nasal bones and the frontal bone.
10. The left temporal bone.
11. The vomer.
12. The left malar bone.
13. The left mastoid process.
14. The angle of the lower jaw.

Fig. 2. Photograph of the same skull as in Fig. 1 (*from the back*).

1. The vault of the cranium.
2. The inter-parietal (sagittal) suture.
3. The left parietal eminence.
4. The lamboid suture between the left parietal and occipital bones.
5. The left mastoid process.
6. The upper angle of the occipital bone.
7. The lamboid suture between the right parietal and occipital bones.
8. The external occipital protuberance.
9. The right mastoid process.

Fig. 3. Photograph of the same skull as in Figs. 1 and 2 (*from the left side*).

1. The vault of the cranium.
2. The coronal suture.
3. The superciliary ridge.
4. The external angular process of the orbit.
5. The great wing of the sphenoid bone.
6. The nasal bone.
7. The zygoma.
8. The chin.
9. The upper curved line of the parietal bone.
10. The lower curved line of the parietal bone.
11. The squamous suture.
12. The external occipital protuberance.
13. The mastoid process.
14. The angle of the inferior maxillary bone.

Fig. 4. Photograph of an African skull (*from above*).

1. The external angular process of the left orbit.
2. The frontal bone.
3. The coronal suture.
4. The left parietal eminence.
5. The junction of the sagittal and lamboid sutures.
6. The occipital bone.
7. The coronal suture.
8. The inter-parietal (sagittal) suture.
9. The right parietal eminence.

Fig. 5. Photograph of the same skull as in Fig. 4 (*from below*).

1. The incisor teeth.
2. The palate.
3. The right zygomatic arch.
4. The pterygoid process of the sphenoid bone.
5. The apex of the left temporal bone.
6. The left condyle of the occipital bone.
7. The foramen magnum.
8. The lower curved line on the occipital bone.
9. A bicuspid tooth.
10. A malar tooth.
11. The left zygomatic arch.
12. The pterygoid process of the sphenoid bone.
13. The apex of the left temporal bone.
14. The left condyle of the occipital bone.
15. The external occipital protuberance.

Fig. 6. Photograph of the interior of an adult male European skull (*section from before backward*).

1. The frontal sinus.
2. The sphenoidal and ethmoidal cavities.
3. Opening into cavity of the superior maxillary bone (Antrum of Highmore)
4. The palate bone.
5. The incisor teeth.
6. The lateral sinus.
7. The pterygoid process of the sphenoid bone.
8. The styloid process.
9. The mastoid process.

fig. 1.

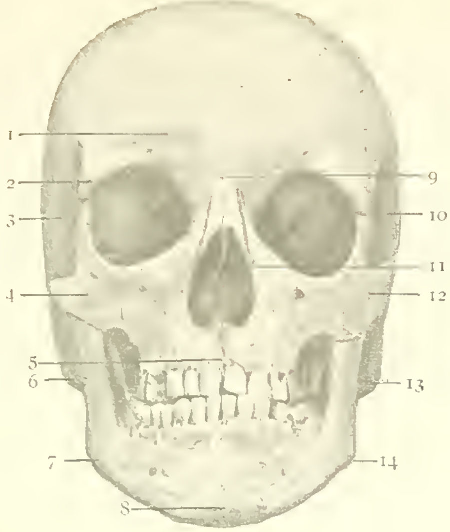
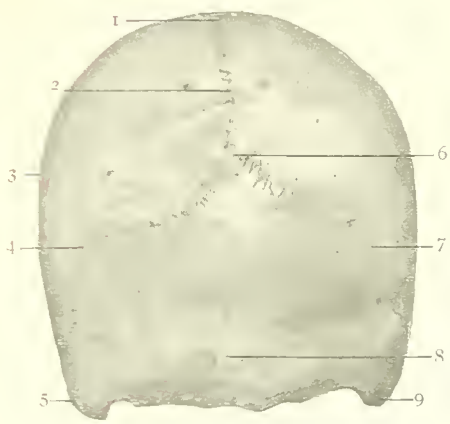


fig. 4.

fig. 2.



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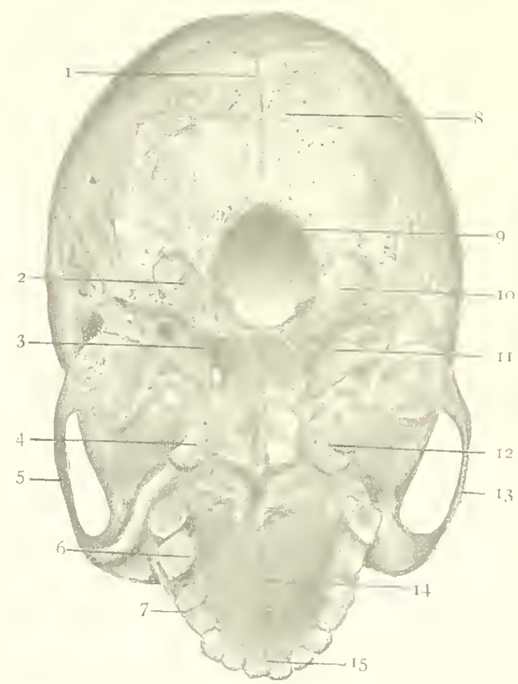

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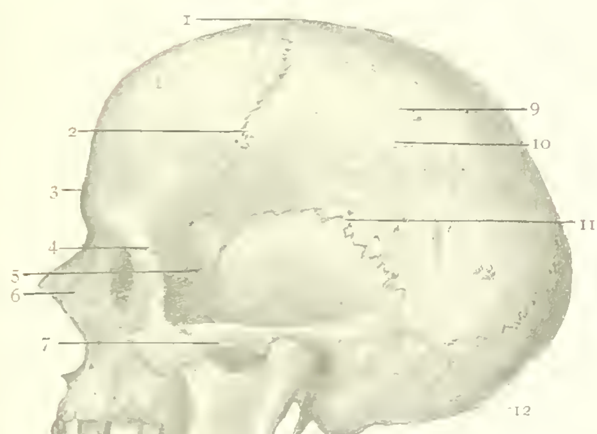


fig. 6.

PLATE 14.

Fig. 1. Photograph of the skull of an adult male European, aged 37 years (*right side*).

Fig. 2. Photograph of the skull of an adult male African (*right side*).

Fig. 3. Photograph of the skull of an adult male ourang outang (*right side*).

These figures are arranged to show the *comparative degree of the facial angle.*

Fig. 4. Photograph of the skull of an infant at birth (*from the front*).

1. The anterior fontanelle.
2. The right frontal bone.
3. The frontal suture.
4. The right superior maxillary bone.
5. The suture between the two halves of the lower jaw.
6. The left frontal bone.
7. The suture between the two upper jaw-bones (inter-maxillary).

Fig. 5. Photograph of the skull of an infant at birth (*left side*).

1. The anterior fontanelle.
2. The frontal eminence.
3. The superior maxillary bone.
4. The inferior maxillary bone.
5. The parietal eminence.
6. The undeveloped mastoid process.

Fig. 6. Photograph of the skull of an adult male European, aged 85 years, showing the obliteration of the sutures and the shape of the jaw-bones after the entire series of the teeth have fallen out (*left side*).

1. The frontal eminence.
2. The position of the coronal suture.
3. The superciliary ridges.
4. The superior maxillary bone.
5. The inferior maxillary bone.
6. The styloid process.
7. The mastoid process.

PLATE 14

fig. 1

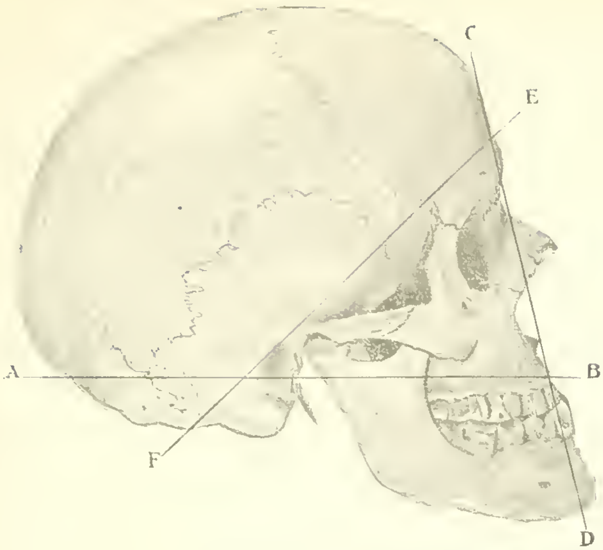


fig. 1

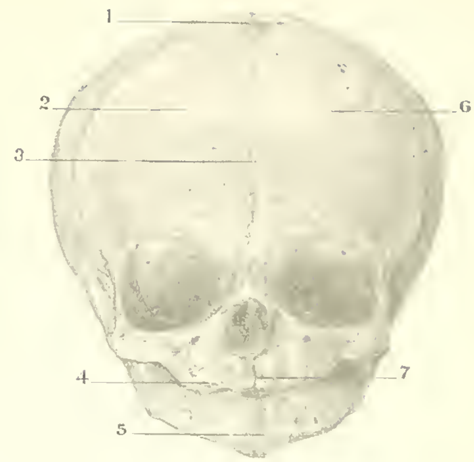


fig. 2

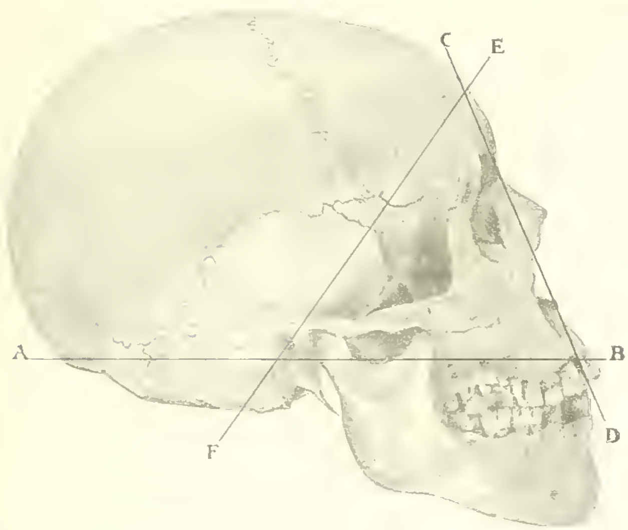


fig. 5

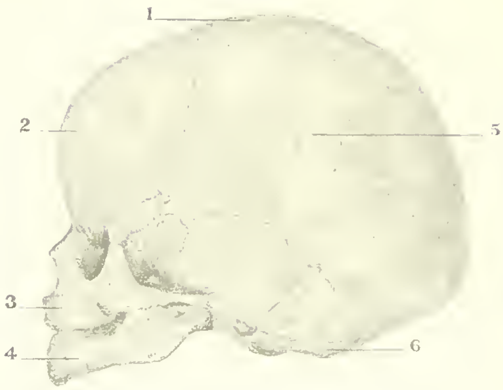


fig. 3

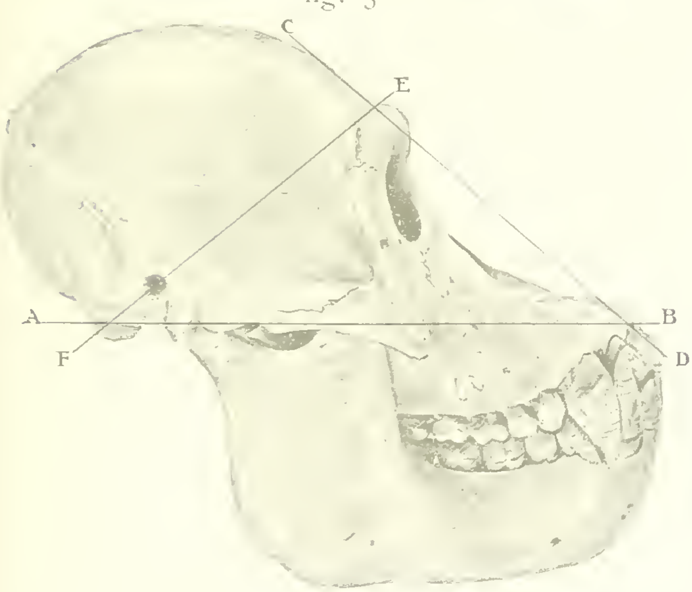
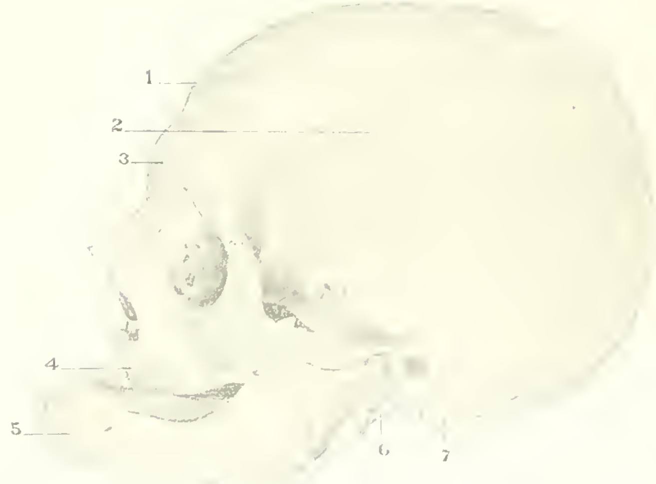


fig. 6



THE MUSCLES OF THE HEAD AND FACE.

THE muscles of the head and face (Plates 15 and 16), especially those called from their action *the muscles of expression*, are of finer texture and paler color than the muscles generally in other parts of the body. The muscles of expression have no proper tendons of origin or insertion, are destitute of sheaths, and blend with adjacent muscles by the most complex and delicate interlacement of their fibres, so that they do not present the same arrangement in every individual. They often vary in development on the two sides of the same face, thereby influencing the character and degree of the expressions.

The frontal muscles (Plate 15, Figs. 1 and 2) are the front portions of the cutaneous muscle of the scalp (the occipito-frontalis). They are upon either side of the forehead, and in bald persons are often plainly noticeable in outline. They are formed of a thin layer of pale fleshy fibres which extend upward about two inches above the eyebrows, usually where the hair begins, and they join with the tendinous aponeurosis (epi-cranium) which is a pearly-white membrane extending over the entire top of the head (Plate 15). At the root of the nose in the middle line, the fibres of the frontal muscles intersect and send downward slips which are continuous with the nasal muscles. The middle and outer fibres commingle with those of the constrictor muscles of the eye-lids (orbicular). Some of the innermost fibres are attached to the nasal bones, some of the outer to the outer angles of the orbits; but in no other part have they a bony origin.

The *occipital portions* of the scalp muscle arise by short tendons from the upper curved lines on the occipital bones and the mastoid processes of the temporal bones, and consist of parallel fibres darker than those of the frontal portions, about an inch in length (Plate 15, Fig. 1, and Plate 16, Fig. 1). They join the aponeurosis, which at the occipital prominence separates them by a median area.

The aponeurosis is very loosely attached to the membrane covering the cranium (peri-cranium) so that the scalp has considerable mobility.

Action of the frontal muscles.—This is seen in many of the ordinary facial expressions, as *surprise* and *doubt*, when the frontal muscles are contracted and produce the characteristic transverse wrinkling of the forehead.

The skin covering the head, which constitutes the *scalp*, is peculiarly constructed for the growth of the hair and for protection to the vault of the cranium. It is thicker and tougher than in any other part of the body.

The *hairs of the scalp* mostly diverge from the parietal eminences on either side. They vary in character according to their color, length and diameter, being straight, wavy, curly and woolly according to the straight or curved axis of their follicles. Fair hairs are more delicate and finer than dark hairs, and are usually more closely set in the scalp.

The muscles in relation to the nose are on each side, the pyramidal, the compressor of the nostril and the depressor of the wing of the nose.

The pyramidal muscles (Plates 15 and 16) are really prolongations of the innermost fibres of the frontal muscles downward over the bridge of the nose. upon which they intersect with one another. The innermost fibres blend with the adjacent compressor and orbicular muscles.

Action of the pyramidal muscles.—Acting from below, they draw downward the inner angles of the eyebrows, thus producing transverse wrinkles at the root of the nose, or acting from above they serve as dilators of the nostrils.

The *compressor muscles* (Plates 15 and 16) are triangular in shape and arise from the upper jaws on each side above the canine teeth and join by a tendinous expansion over the dorsum of the nose.

Action of the compressor muscles.—They compress the lateral cartilages and produce the pinched appearance seen in labored breathing.

The *depressor muscles* arise from the upper jaw in front of the compressors and are inserted into the septum and back parts of the wings of the nose.

Action of the depressor muscles of the nose.—Their action serves to emphasize that of the compressors.

Besides the above, there are little bundles of specialized fibres on each side (the *dilator muscles*) which pass from the wings of the nostrils and contiguous nasal processes to the overlying skin. They assist in retaining the proper openings of the nostrils in ordinary respiration, as in sleep, from atmospheric

pressure, but in forced breathing their action is very noticeable, as it also is in the expressions of *pride, anger* and *disdain.*

The *skin over the nose* below the forehead on the sides and over the bridge is thin and loose, but over the cartilaginous portion it is thick and very adherent to the parts beneath.

The muscles of the eye-lids are the orbicular, the corrugator and the elevator, on each side.

The *orbicular* (circular) *muscle* (Plates 15 and 16) surrounds the eyelids, its fleshy fibres being arranged in oval loops which are thicker and redder in relation to the orbits and paler and exceedingly delicate upon the eye-lids. This muscle is attached to the lower and inner borders of the orbits, while above, the fibres interlace with those of the frontal muscle. Upon the cheek the fibres of the orbicular blend with those of the adjacent muscles which elevate the wing of the nose and upper lip.

Action of the orbicular muscle of the eye-lid.—The chief action of the whole of this muscle is that of a *sphincter* as it serves to close the eye-lids, and when this action is forced it will push the eye-ball into the orbit. In winking, only the fibres upon the lids contract. This momentary closure of the lids is accompanied by a slight inward drawing of the inner parts of the lids, which serves to direct the tears toward the tear-duct.

The "crow's feet" of old age are the permanent radiating wrinkles produced by the orbital fibres drawing the brows down and the lower lids up.

The corrugator muscles are merely transverse fibres of the orbicular muscles which arise from the inner parts of the orbits and are inserted into the skin of the eye-brows. They are the *frowning muscles*, because by their special action they wrinkle the forehead vertically (Plates 17 and 18).

The elevator muscles (Plate 12, Figs. 4 and 5) arise within the orbits, pass forward over the eye-balls and are inserted by broad tendons into the cartilages of the upper eye-lids.

Action of the elevator muscles of the upper eye-lids.—They are constantly in action when the eyes are open and are relaxed in sleep. In the tiger and lion these muscles are divided into several bundles, which are attached into as many parts of the upper lids, which, by their united action, hold the

lids away from the eye-balls, so that they present a staring look. This is sometimes the case in man.

The eye-lids (Plate 12, Figs. 5, 6 and 7) are small translucent discs of cartilage which are attached to the margins of the orbits. The upper lid is larger, and broader in the middle, and more movable than the lower. The interval between the two lids is called the *fissure* (or rictus), and it varies with the relation of the lids to the eye-ball, according as the eye is directed upward, forward and downward. When the eyes are looking upward the fissures are dilated, the upper lids arching as high as the upper margins of the corneæ, while parts of the white coats of the eye-balls are seen above the lower lids. When the eyes are looking straight forward, the upper lids slightly cover the tops of the corneæ, and the lower lids are on a level with their lower borders. When the eyes are downcast, the upper lids cover the corneæ as far as the tops of the pupils, and the lower lids are on a line with the lower borders of the corneæ.

The lower lids hold this relation also in ordinary closure of the eyes.

The skin over the orbits and eye-lids is of peculiar interest.

The eye-brows consist of the arching folds of integument over the orbital ridges of the frontal bone. They are connected with the constrictor muscles of the eye-lids, and especially with the transverse fibres of the orbiculars known as the corrugator muscles. The eye-brows support short thick hairs which at the nasal sides of the arches are directed upward and forward, and for the rest of the arches upward and outward with increasing obliquity. Below the eye-brows the skin is always destitute of fat and spread out in a very delicate texture over the eye-lids. So thin is the skin upon the upper lid that when it is closed over the eye, not only can its blood-vessels be readily seen but often the iris can be distinguished through the tissues. There is sometimes a cutaneous fold at the inner border of the upper lid (Plate 12, Fig. 7), which presents an important element in the study of individual features that the artist would do well to observe in portraying a likeness.

The thickest parts of the eye-lids are their free borders. They are straight, and when the eyes are closed they are in accurate apposition. The *eye-lashes* are arranged on their edges in several rows, those of the upper lid being longer and more numerous than those of the lower lid. The upper ones curve upward while the lower curve downward.

It should be noted that there are always pads of fat within the orbits in a healthy state upon which the eye-balls rest, and when there is wasting of this fat, as in disease or old age, the eyes are sunken. The apparent size of the eye-balls in a measure depends upon the degree to which the eye-lids are separated. Usually the outer and inner corners formed by the upper and lower lids of the two eyes are on a horizontal line. The eyes of the Chinese and Japanese are peculiar, because the outer corners of the lids are raised and thus produce a distinctive oblique appearance. There is a difference in the outer and inner corners of the eye-lids which the artist should particularly observe. The outer corner is formed by the upper lid folding over the lower. At the inner corner there is a small vascular elevation formed by a fold of the mucous membrane where the tear-ducts receive the tears and convey them to the interior of the nose. At the latter is also a little subcutaneous band (tendo-oculi), which connects the lower eye-lid with the inner wall of the orbit, and occasions a tightening of the integument in this locality.

The white *(sclerotic)* coat of the eye-ball (Plate 12) is the protective covering over the sensitive interior *(retina, etc.)*. The *cornea* is the transparent prominent part which, somewhat like a watch-glass, is applied upon the sclerotic, and through which the iris can be seen.

The *iris* (rainbow) is the circular contractile membrane in front, with a variable opening called the *pupil*, which regulates the amount of light entering upon the interior of the eye-ball, and corresponds to a diaphragm of a photographic camera. The color of the eye depends upon the tint of the pigment in the iris. The iris is entirely under the control of the sympathetic nervous system, the pupil being dilated in the dark, and contracted in bright light. It is often peculiarly dilated upon arrested exercise, as after dancing. The pupil is normally always round and a little to the inner (nasal) side of the centre of the iris. The exposed portions of the cornea and sclerotic and the ocular portions of the lids are lined by a membrane *(conjunctiva)*, which is kept moist by the tears. It is owing to the glistening of this membrane when light falls on it that what is called "the high light of the eyes" becomes an important factor in expression.

The muscles which surround the mouth are remarkable for their interdependence and for their great mobility.

The *orbicular muscle of the mouth* is composed principally of circular fibres, like other sphincter muscles, and has very slight attachments to the neighboring bones. The variety in the prominence of the lips in different individuals depends upon the size and thickness of this muscle. It consists of two portions, each possessing very marked differences from the other in the arrangement of its fibres.

The *labial portion* (the lips) is composed of very thin pale fibres surrounding the mouth and is not attached to the bone. The *facial portion* is broader, its fibres at the outer borders of the upper and lower lips intermingling with the fibres of other muscles which converge toward it from the surrounding parts of the face. It is connected on each side to the bone by two bundles of fibres in the upper lip, one in relation to the incisor teeth, and the other to the septum of the nose, and by a single bundle on each side, in the lower lip to the lower jaw in relation to the canine tooth. The little furrow (the philtrum) usually noticeable in the female face from the nose to the upper lip, is formed by two tiny slips extending from the orbicular to the septum of the nose.

Action of the orbicular muscle of the mouth.—The ordinary action of this muscle closes the lips, and on account of the intimate connection with the skin of the lips, its forcible contraction produces radiating wrinkles about the mouth in the skin of elderly persons. The orbicular counteracts all the other muscles which move the lips, the infinite play and variety of expression about the corners of the mouth depending upon the counterbalancing of their opposing actions.

There are upon each side of the face muscles which arise from the nasal processes of the upper jaws near the orbits. They are called the *elevators of the wings of the nose and upper lips*, from their action upon those parts into which they are inserted.

Action of the elevator muscles of the wings of the nose and upper lips.—These muscles serve to dilate the nostrils and to draw upward at the same time the upper lips and wings of the nose, thus producing the changes in the countenance in the expressions of *indignation*, *disgust* and *derision* (Plate 18). Their habitual

use occasions the furrows which extend from the sides of the nose to the corners of the mouth.

Besides these there are other elevator muscles which act upon the upper lip alone (the proper elevators), and one on each side which blends with the fibres of the orbicular at the angles of the mouth (elevators of the angles).

The corners of the mouth when it is closed are in relation to the first bicuspid teeth. There is great variability in the length and thickness of the lips, depending upon the peculiarities of age, sex and race. The vermilion color of the borders of the lips is due to the translucent nature of the epithelium with which they are covered, and to the vascularity of the subjacent tissues which can be seen through it. When the mouth is closed, the upper lip is in the form of a bow, which adds to the attractiveness of this part of the female face. The upper lip usually advances beyond the lower lip, and sometimes this gives a *pouting expression.* When it is shorter than the lower lip, without being less prominent, it is often a distinctive feature contributing much to the beauty of the mouth.

The groups of the facial muscles above explained constitute those muscles which by their action produce what may be described as the *intellectual expressions* (Plate 16, Fig. 1). They are especially developed in the human face and give character to the features, according to the predominant traits of the individual even in repose, or after death. As Sir Charles Bell pointed out, their function is to produce the nobler expressions of the human countenance, in contrast to that of the muscles peculiarly animal (Plate 16, Fig. 2), which act upon the lower part of the face.

Adjoining the muscles which raise the angles of the mouth, there are the *zygomatic major and minor*, which have origin higher on the face, from the cheek at its junction with the zygoma of the temporal bone, and the fibres of which also blend at the corners of the mouth, with the orbicular.

Action of the zygomatic muscles.—Their action is seen in *laughing* and *snarling.* They are especially developed in the dog.

Counteracting the above are muscles which act upon the lower lip.

The *depressor muscle of the angle of the mouth* on each side arises from the subjacent part of the lower jaw, and blends at the angle of the mouth with the other muscles there, but especially with the zymotic or snarling muscle. The peculiar interlacement of the fibres of these muscles with so many others at the corners of the mouth (Plates 17 and 18) renders these parts the most mobile of the face.

Action of the depressor muscle of the angle of the mouth.—This muscle is the most expressive of all the facial muscles and plays an important role in *melancholy and sorrowful emotions* (Plate 18, Figs. 5 and 6).

The lower lip is also provided with other depressor muscles which, taking origin from the body of the lower jaw, draw the lower lip downward and a little outward as in the expression of *irony* or *sarcasm.*

Besides these, two small bundles of fibres occur in the dense tissue composing the chin which raise it (elevators of the chin) and protrude the lower lip (Plate 15, Figs. 1 and 2).

Beneath the integument of the front and sides of the neck (page 47) in man there is a rudimentary muscular layer of tissue (platysma) which extends on to the face as high as the cheek (Plate 15, Fig. 5). The topmost fibres pass transversely to the corners of the mouth and blend with the other muscles. These fibres have been called the *laughing muscles* (risorius) because sometimes they are unusually developed and then produce the convulsive twitchings in the face which become manifest in good humor. There is often great diversity in the development of these fibres on the two sides of the same face. As they usually exist they produce the smile of *scorn* or *derision.*

Within the mouth on each side there are the *buccinator muscles*, which are properly a continuation of the series of constrictor muscles of the pharynx (Plate 20), as they are chiefly concerned with keeping the food between the teeth during mastication. These muscles, unlike the proper facial muscles, are provided with sheaths which greatly increase their power, and as they are inserted within at the corners of the mouth, they widen its aperture by drawing upon its corners (Plate 20).

Action of the buccinator muscles. Their action is seen in *whistling* or in blowing a trumpet.

The muscles of the human face are difficult to understand intelligently for many reasons, and it is not enough to enumerate them with a brief statement of their functions. They should be critically examined by all who are conscientious students. The author has taken pains therefore to show drawings of the facial muscles which he has verified by dissection, and to dwell upon such details regarding them as he considers of use in portraiture. Knowledge of the probable arrangement of the various muscles beneath the skin should explain many of the facial peculiarities and serve to fix attention, just as observance of the bony landmarks must help in determining the form of the head.

The skin of the face is generally very fine and thin and adherent to the parts beneath, except upon the eye-lids, as already mentioned. There is much fat in the sub-cutaneous tissue of the face, especially in the front parts of the cheeks in relation to the zygomatic muscles which take origin from the cheek bones and pass to the mouth. The intimate association of the skin with many of the subjacent muscles produces, through their habitual use, the facial *dimples*, *furrows* and *markings* characteristic of certain expressions. A careful study of these lines and their varying modifications will prove of great value to the artist, especially in young children. In the ignorant who cannot readily communicate ideas or describe sensations by speech, they are usually very much exaggerated.

The nose, besides being the organ of the special sense of smell, is the channel for respiration when the mouth is closed. The nostrils being cartilaginous and movable by the adjacent muscles, are expanded and contracted in correspondence with the motions of the chest, especially when the respiration is affected by the emotions. It should be remembered that the changes of the features in the human countenance are not directly due to the influence of the mind, and that the expressions characteristic of strong emotions, passions, or affections, are the physical manifestations of impressions upon the heart and lungs. This is evident in the contortions of a child's face at birth, before the brain is capable of mental effort. The habitual expressions which stamp the features with individual character are often due to the exercise of the will in self-control, or to the mind which dwells upon certain passions. On this account life-masks are of great value.

The muscles which are attached to the eye-balls and control their movements are of peculiar interest—for they serve to bring the apparatus of vision in relation to external objects. There are *four straight and two oblique muscles of the eye-ball.* (Plate **12**, Figs. 4 and 5.)

Action of the muscles of the eye-balls. Their action is chiefly in adjusting the two eyes toward a common point in order to obtain single vision.

The incidental movements attending the expressions in *hope, devotion, shyness, cunning or shame* are also produced by them because they are not only under the influence of the will, but are also affected by the state of the heart and mind. To these influences are due the wonderful changes of the countenance which may say more than ever can be translated by word of mouth.

Much depends upon the organ of the eye, the muscles which act upon it, the eye-brows, the eye-lids, the eye-lashes—in expression, and they should be studied with extreme care. The orbicularis (page 33) closes the eye-lids. Its fibres about the margins of the lids are extremely slender and fine: they serve to close the eye gently as in *winking* or in *sleep.* The stronger band of fibres round the orbits are brought into action and snap the lids together when something irritating is thrown into the eye. The outer circles also oppose the frontal muscles and draw down the eye-brows. The nasal slip (page 32) from the frontal acts differently from the rest of that muscle and draws the inner extremity of the eye-brow downward. The corrugator muscle (page 33) being inserted into the skin under the eye-brow serves to knit the brows, when the fellow muscles act in unison. Elevation of character is indicated by lines upon the forehead which result from the habitual play of these muscles. If there is fulness of the forehead and round the eyes it is apt to give a dull, heavy expression.

Beauty usually implies a large eye, and it is in the eye that one looks for meaning, sentiment and reproof. An effect of power is greatly due to a projecting eye-brow. The eyes naturally roll upward in sleep, languor and depression. In bodily pain or fear of death this action is irresistible. Bell attributes to the eye the loftier emotions, and describes the effect of its influence "in reverence, in devotion, in agony of mind, in all sentiments of pity."

The straight muscles of the eye-ball are governed by the will alone, but the

oblique muscles have sympathetic nerve filaments which bring them under the influence of the sympathetic nerve, so that they act when the other muscles cease to operate. Hence, in sleep, in fainting or in approaching death, the eye-balls are revolved, and it is consolatory to reflect that at such moments the semblance of agony may be only apparent, and dependent on the condition of insensibility.

We see this, often where a person is groping for a name or word for the moment forgotten, and is apt to look upward in the corner of the room for the lost thought; but always the muscles of the neck and trunk move in accordance with the glance. It is not only the eye-balls which are turned.

In *laughing* or *singing* the orbicular muscles act powerfully and press against the eye-balls, so as to prevent too great a determination of blood to the delicate vessels of the organ, which would otherwise be induced by these emotions. In forced inspiration we instinctively droop the lids, and in *sneezing* and *coughing* it is the same

In the case of a man suffering from intoxication, it is curious to note how the muscles of the eye-balls contend with each other for mastery; but this may be noticed equally to be the case throughout the whole muscular system in such a condition.

The muscles of the Ear.—When the skin is removed from the side of the head, the *temple*, there is found to be a variable amount of fat in the sub-cutaneous tissue, beside the rudimentary auricular muscles, one in front, one above, and one behind the auricle (Plate 16, Fig. 1). These *auricular muscles* are very imperfectly developed in man, and consequently the auricle possesses a limited functional capability.

The auricle, commonly called the ear, is formed of a fibro-cartilaginous framework, covered with integument, and is expanded from the side of the head. There are many peculiar elevations and concavities in the auricle which are important and deserving of close attention by a student of physiognomy. The border of the auricle is folded over and is called the *helix*. The elevation within it is the *anti-helix*. The deep concavity leading into the auditory opening is the *concha*. In front of the concha is the *tragus*, a conical elevation often provided with hairs. Below the concha is the soft pendulous portion of the auricle, the *lobule* (Plate 16, Fig. 1), which has no cartilage in it.

There is great variability in the development of the auricle, both as to its conformation and as to the manner in which it is set on the side of the head. The margin of the folded border or helix is often irregular and presents a conical process at its upper part. The ancients used to represent the Fauns and Satyrs as having the helix unfolded so that the conical process gave the auricle a pointed appearance. Darwin laid stress on this feature of the human ear as an evidence of man's descent from the ape. The skin over the auricle is thin and generally closely adherent to its framework. The auricle is a conspicuous and distinctive feature in every individual and very difficult to represent correctly, even with the closest observation. Below and in front of the ear is the large salivary gland (parotid) (Plate 20), which, although bound down by the fascia covering the adjacent (masseter) muscle, contributes to the roundness of the face below the zygoma.

Beneath the auricular muscles is the *temporal fascia*, a strong, pearly white sheath which encloses the temporal muscle. The sheath is attached to the uppermost of the temporal ridges on the side of the skull (Plate 15, Fig. 1, and Plate 16, Fig. 2.)

The *temporal muscle* (Plate 15, Figs. 1 and 2, and Plate 16, Fig. 2) is fan-shaped, its fibres converging to a strong tendon inserted at the front process of the branch of the lower jaw. The temporal muscle arises from the lowermost ridge of the temporal bone.

Action of the temporal muscle.—Its action is to draw forcibly the lower jaw up against the upper, and its chief use is in mastication. There is usually a pad of fat between the sheath of the muscle and its insertion at the zygoma, which contributes to the fullness of the side of the head, and when it becomes wasted in old age or from disease it occasions the noticeable hollows at the temples in those conditions.

The *masseter muscles* (Plate 16, Fig. 2) arise by short, thick tendons from the upper jaw-bones, and the zygomas in two strata of fibres which pass obliquely backward and are inserted into the angles and branches of the lower jaw. The masseter muscles assist largely in producing the contour of the lower part of the face.

Action of the masseter muscles.—They draw upward the lower jaw and assist the temporal muscles in mastication.

PLATE 15.

Fig. 1. Diagram of the muscles of the head, face and neck (*right side*).

1. The aponeurosis of the occipito-frontal muscle (galea capitis).
2. The position of the upper curved ridge on the temporal bone.
3. The temporal muscle.
4. The external auditory opening.
5. The occipital muscle.
6. The external occipital protuberance.
7. The mastoid process.
8. The sterno-cleido mastoid muscle.
9. The posterior portion of the digastric muscle.
10. The trapezius muscle.
11. The complexus muscle.
12. The calvicular portion of the sterno-mastoid muscle.
13. The frontal muscle.
14. The pyramidalis nasi muscle.
15. The orbicularis palpebrarum muscle.
16. The compressor naris muscle.
17. The levator labii superioris muscle.
18. The zygomatic muscle.
19. The orbicularis oris muscle.
20. The levator menti muscle.
21. The depressor anguli oris muscle.
22. The anterior portion of the digastric muscle.
23. The anterior portion of the omo-hyoid muscle.
24. The sterno-thyroid muscle.
25. The sternal portion of the cleido-mastoid muscle.

Fig. 2. Diagram of the muscles of the head, face and neck (*from the front*).

1. The right frontal muscle.
2. The position of the corrugator supercilii muscle.

Fig. 2—continued.

3. The external angular process of the orbit.
4. The orbicularis palpebrarum muscle.
5. The zygomatic muscles (major and minor).
6. The right masseter muscle.
7. The levator menti muscle.
8. The depressor anguli muscle.
9. The hyoid bone.
10. The sterno-cleido-mastoid.
11. The sterno-hyoid muscle.
12. The clavicular portion of the sterno-mastoid muscle.
13. The posterior portion of the omo-hyoid muscle.
14. The left frontal muscle.
15. The corrugator muscle.
16. The compressor naris muscle.
17. The zygomatic muscles.
18. The left masseter muscle.
19. The orbicularis oris muscle.
20. The left depressor anguli oris muscle.
21. The sterno-cleido-mastoid muscle.
22. The clavicular portion of the sterno-mastoid muscle.
23. The trapezius muscle.

Fig. 3. Diagram of the muscles about the eye-lids (*left side*).

1. The frontal muscle.
2. The pyramidal muscle of the nose.
3. The orbicular muscle of the eye.
4. The compressor muscle of the nose.

Fig. 4. Diagram of the muscles at the wing of the nose and the upper lip (*left side*).

1. The elevator muscle of the nostril.
2. The elevator muscle of the upper lip.
3. The superior labial portion of the orbicular muscle.

(*Continued*)

PLATE 15

fig. 1.

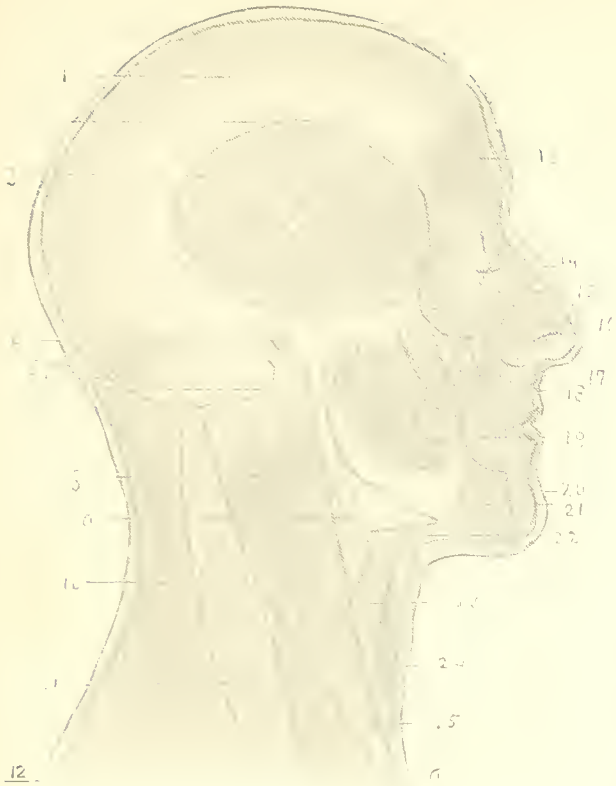


fig. 2.

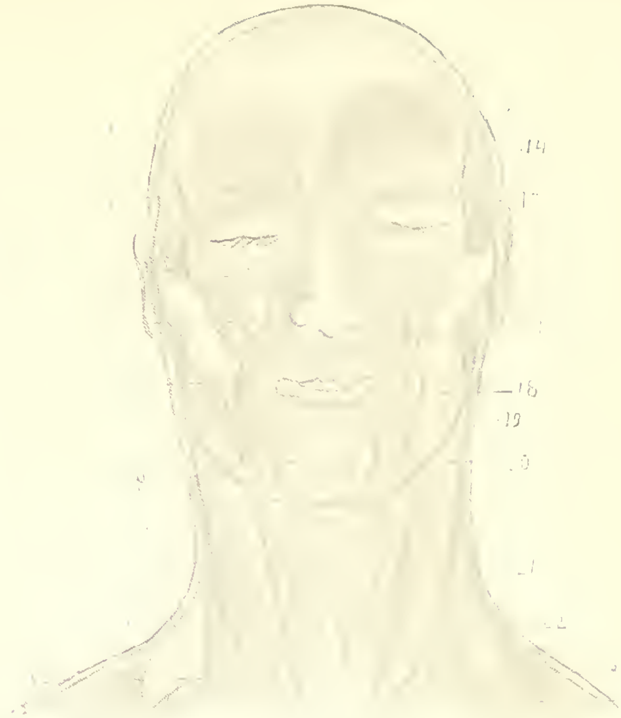


fig. 3.

fig. 4.

fig. 5.

fig. 6.

fig. 7.

PLATE 15. (*Continued*)

Fig. 5. Diagram showing the upper portion of the platysma muscle blending with the other muscles at the corner of the mouth (*left side*).

1. The frontal muscle.
2. The pyramidal muscle of the nose.
3. The elevator muscle of the nostril.
4. The elevator muscle of the upper lip.
5. The zygomatic minor muscle.
6. The zygomatic major muscle.
7. The orbicular muscle of the mouth.
8. The musculus risorius (laughing muscle).
9. The platysma myoides muscle.

Fig. 6. Diagram of the muscles of the upper lip (*left side*.)

1. The elevator muscle of the upper lip.
2. The zygomatic minor muscle.

Fig. 6—continued.

3. The zygomatic major muscle.
4. The superior labial portion of the orbicular muscle.

Fig. 7. Diagram of the muscles about the mouth and lower lip (*left side*).

1. The depressor muscle of the nostril.
2. The superior labial portion of the orbicular muscle.
3. The inferior labial portion of the orbicular muscle.
4. The elevator muscle of the chin.
5. The depressor muscle of the lower lip.
6. The buccinator muscle.
7. The depressor anguli oris muscle.

PLATE 16.

Fig. 1. The muscles of the head and face upon the left side whose action produce the intellectual expressions.

1. The scalp.
2. The frontal muscle.
3. The superciliary ridge.
4. The position of the corrugator muscle.
5. The attachment of the frontal muscle at the external angular process of the orbit.
6. The pyramidalis nasi muscle.
7. The elevator muscle of the wing of the nose.
8. The compressor naris muscle.
9. The elevator muscles of the wing of the nose and upper lip.
10. The proper elevator muscle of the upper lip.
11. The dilator naris muscle.
12. The orbicularis oris muscle.
13. The tendon of the occipito frontalis muscle (galea capitis).
14. The upper curved line on the parietal bone.
15. The lower curved line on the parietal bone.
16. The attolens aurem muscle.
17. The attrahens aurem muscle.
18. The retrahens aurem muscle.
19. The concha.
20. The auricle.
21. The occipital portion of the occipito-frontalis muscle.

Fig. 1.—continued.

22. The lobe of the ear.
23. The molar teeth.
24. The external pterygoid process of the sphenoid bone.
25. The styloid process of the temporal bone.

Fig. 2. The left side of the head and face showing the muscles whose action produce the expressions peculiarly animal.

1. The scalp.
2. The superciliary ridge.
3. The zygoma.
4. The zygomaticus minor muscle.
5. The zygomaticus major muscle.
6. The orbicularis oris muscle.
7. The levator menti muscle.
8. The depressor muscle of the lower lip.
9. The depressor muscle of the angle of the mouth.
10. The anterior portion of the digastric muscle.
11. The hyoid bone.
12. The attachment of the temporal muscle.
13. The temporal muscle.
14. The masseter muscle.
15. The masseter muscle.
16. The posterior portion of the digastric muscle.
17. The angle of the lower jaw.
18. The stylo-hyoid muscle.

Fig. .

Fig. 2.

PLATE 17.

Fig. 1. Drawing of the face as in laughter.

Fig. 2. Diagram of the facial muscles as in laughter.

Fig. 3. Drawing of the face as in astonishment.

Fig. 4. Diagram of the facial muscles as in astonishment.

Fig. 5. Drawing of the face as in horror.

Fig. 6. Diagram of the facial muscles as in horror.

PLATE 17

Fig. 1

Fig. 2

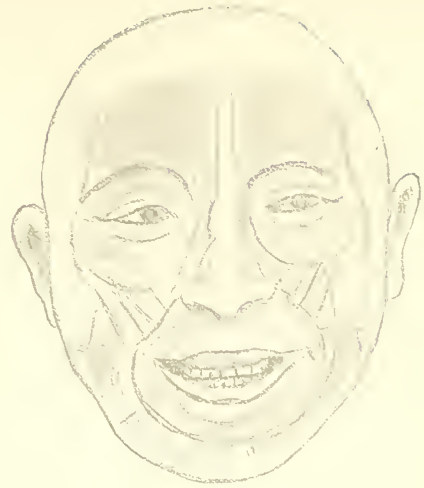


Fig. 3

Fig. 4

Fig. 5

Fig. 6

PLATE 18.

Fig. 1. Drawing of the face as in anger.

Fig. 2. Diagram of the facial muscles as in anger.

Fig. 3. Drawing of the face as in disgust.

Fig. 4. Diagram of the facial muscles as in disgust.

Fig. 5. Drawing of the face as in grief.

Fig. 6. Diagram of the facial muscles as in grief.

N. B.—The drawings upon Plates 17 and 18, showing the face in the several typical expressions, were suggested by a remarkable work, entitled "Symphonies d'Expressions," by Maurice Heyman, in which that artist has endeavored to portray through a study of his own features the progressive changes observable in the various expressions.

The diagrams of the facial muscles are based upon the author's dissections and are intended to show how the same muscles under different influences, can produce the different expressions.

PLATE 18

Fig. 1

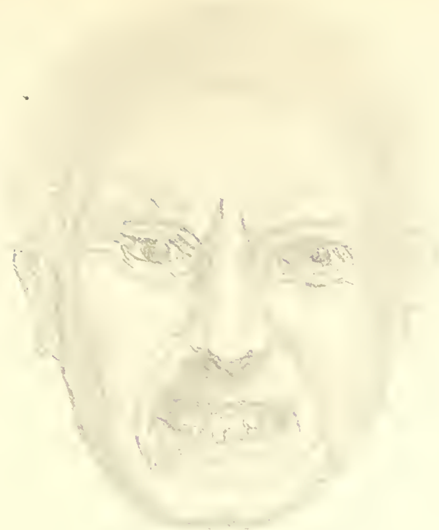


Fig. 2

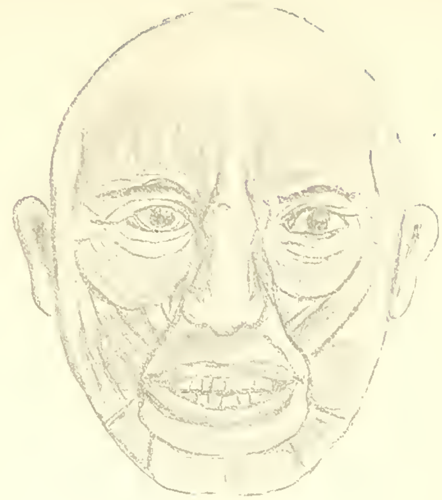


Fig. 3

Fig. 4

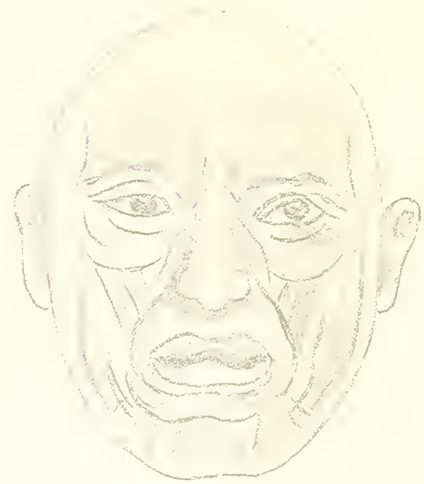
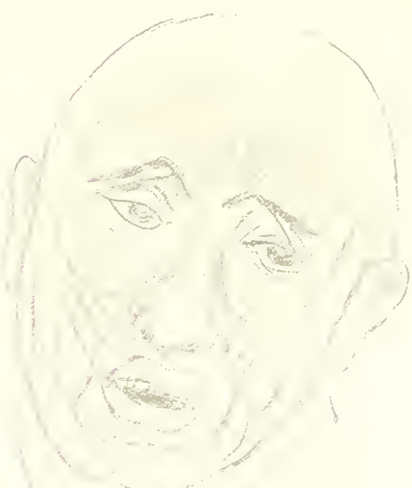


Fig. 5

Fig. 6



THE NECK.

THE cranium is supported somewhat behind its axis upon the most flexible portion of the vertebral column, which is the *skeleton of the neck*, and is composed of seven irregular bony segments called vertebræ (Plate 19). The soft structures in this region cover so well the skeleton that its prominences are not conspicuous (Plate 20), but when the head is bent forward the spines of all the vertebræ, excepting the topmost, can be felt through the integument, and the spine of the seventh is always so well marked that it is a landmark and is called the *prominent vertebra*. When the body is upright with the shoulders squared, and the head held so that the face looks straight forward, a line drawn from the occipital protuberance along the lower jaw to the chin is about parallel with a line drawn from the lower border of the first thoracic vertebra to the top of the sternum or breast bone, and these two lines may be considered as the upper and lower limits of the neck. (Plates 19 and 20.)

The several vertebræ which have features of interest in this connection are best understood by an examination of Plates 11 and 38. The chief points to be noted are the differences between the first and second vertebræ. The first is called the *Atlas vertebra* (Plate 11, Fig. 9) because it supports the head, after the fable of Atlas supporting the globe on his shoulders. It is especially adapted for the reception of the condyles of the occipital bone (Plate 10, Fig. 3) so that in the nodding motions of the head, as in expressing affirmation, the skull rocks forward and backward upon the Atlas vertebra. The second cervical vertebra is provided with a peculiar bony pivot which projects upward from the thick part of it (Plate 11, Figs. 10 and 11), and about this the first vertebra, carrying the skull with it, rotates in the right and left sideway movements of the head as in expressing negation. The intervening vertebræ between the second and the seventh have thick bodies for support of the head and flattened arches for protection of the spinal cord. (Plates 19 and 21.)

The seventh vertebra, or *vertebra prominens* (Plate 11, Fig. 12), is peculiar for the length of its spinus process. Between the several vertebræ in this

region there are, as elsewhere in the spinal column, intervening discs of cartilage (Plate 24). In the neck the vertebræ and cartilages are so arranged that they admit of great freedom of motion (Plates 22 and 23).

Extending downward from the occipital protuberance and attached to the spines of all the cervical vertebræ, except the first, is a dense fibrous structure called the *ligamentum nuchæ*. In the ruminating animals it serves to sustain the weight of the head, but in man it is rudimentary and merely forms a septum or partition between the lateral muscular masses at the back of the neck.

In the front of the neck, the hyoid bone and the external cartilages of the larynx should be noted in relation to the chin above, and the top of the sternum below (Plate 19). These structures are very movable in order that they may accommodate themselves to the efforts of swallowing and forced respiration, and to changes of position in consequence of the flexibility of the cervical vertebræ. In the adult, when the head is in the erect position (Plates 19 and 20), *the hyoid bone* can be felt just below the lower jaw. About three-quarters of an inch below the hyoid bone is the *thyroid cartilage*, the notch in front of which, or *Adam's Apple*, is always recognizable, but more prominent in the male than in the female.

At the lower border of the thyroid cartilage is a depression and then a slight prominence formed by the *cricoid cartilage*, which is a landmark, because it can be easily detected in fat as well as in lean persons of both sexes and at all periods of life. In the adult, when the head is bent backward, the space between the top of the sternum and the chin is about double that which it measures when the head is in the natural position, and it is chiefly increased between the chin and the cricoid cartilage. In the child, however, with the head similarly placed, the space is increased between the cricoid cartilage and the top of the sternum, because in the child the cricoid cartilage occupies relatively a higher position in the neck, owing to the diminutive size of the larynx.

The *trachea* can usually be felt just below the cricoid cartilage, but it recedes as it descends, and at the root of the neck above the sternum it is at a considerable distance from the surface (Plates 19 and 21).

The general development of the neck varies in different individuals, being proportionate to the stature. The difference in the length of the neck is sometimes more apparent than real, frequently resulting from some peculiarity in the conformation of the shoulders. Its breadth is also variable.

The hyoid bone is unattached to the general skeleton and serves to support the muscles of the tongue (Plate 21, Fig. 1). The elevator muscles of this bone extend from its front portion, or body, to the upper surface of the chin, and also to the ridges on the inner sides of the lower jaw. Their action is noticed in swallowing.

The larynx (Plates 20 and 21) is the commencement of the respiratory passage, and serves as *the organ of the voice.* It consists of a cartilaginous framework in separate pieces, of which the thyroid and cricoid cartilages are the only ones influencing the outward form. *The trachea* is the top of the windpipe, and in the neck is covered by the sterno-hyoid and sterno-thyroid muscles (Plate 15, Figs. 1 and 2).

The sterno-hyoid muscles are two thin fleshy bands which arise from the joints of the clavicles with the top of the sternum and pass beneath the skin to the body of the hyoid bone. *The sterno-thyroid muscles* arise from the top of the sternum and ascend to the sides of the thyroid cartilage (Plate 15, Figs. 1 and 2).

Action of the sterno-hyoid and sterno-thyroid muscles.—The action of these muscles is noticeable in forced inspiration.

Upon each side of the thyroid cartilage there is a lobulated body, *the thyroid glands* (Plate 21, Fig. 1). They are connected by a band of similar substance (the isthmus) which crosses in front of the windpipe below the cricoid cartilage, and ordinarily do not affect the shape of the neck, but when enlarged, as in goitre, they do so considerably. They are naturally larger in the female than in the male, and consequently a woman's neck appears fuller and rounder than a man's.

The digastric muscles (Plate 16, Fig. 2) consist of two fleshy portions united by an intermediate tendon which pierces the tendon of the stylo-hyoid muscle and is attached to the hyoid bone by a loop of the deep fascia. The

posterior portion arises from the temporal bone back of the mastoid process, and the anterior portion is attached to the under part of the chin.

Action of the digastric muscles.—The anterior and posterior portions of the two digastric muscles always act together, but the effect of their action depends upon which two of the three points of attachment are fixed. If the jaw and skull are both fixed, the muscles raise the hyoid bone, as in *swallowing.* If the skull and hyoid bone are fixed, the lower jaw is depressed, as in *yawning.* If the chin is supported so that the jaw and hyoid bone are fixed, the digastric muscles can aid in drawing the skull backward.

The omo-hyoid muscle (Plate 15, Fig. 2) is an interesting little muscle and like the digastric muscle consists of two portions. The inner portion arises from the hyoid bone and descends vertically beneath the sterno-cleido-mastoid muscle (Plate 15, Fig. 2). The outer portion is attached to the root of the coracoid process of the scapula and ascends obliquely. The two portions are connected by an intermediate tendon, which is itself connected by a band of the deep cervical fascia to the clavicle and the first rib.

Action of the omo-hyoid muscle.—This muscle serves, when acting in conjunction with its fellow on the opposite side of the neck, to steady the hyoid bone —as in the effort attending the free use of the larynx for the high notes in singing. Owing to the connection of the middle tendon of the muscle with the clavicle, the contraction of the outer portion, which only occurs during inspiration, offers resistance to the pressure of the atmosphere upon the apex of the pleura and the great veins which are immediately beneath it. In violent efforts this is of great importance, as, in a measure, it regulates the flow of blood to the heart, because the dilatation of the veins at the root of the neck is coincident with the dilatation of the thorax. This action of the omo-hyoid muscle produces a noticeable elevation on the surface above the collar bone, in the interval between the attachments of the trapezius and sterno-cleido-mastoid muscles (Plate 42). It is wonderfully shown in the famous statue of the "Fighting Gladiator," proving the close attention to nature on the part of the sculptor.

The skin over the front of the neck is thin, delicate and very elastic, and is readily raised in folds. The amount of fat in the sub-cutaneous tissues

varies in different localities, but it is apt to become diffused above the hyoid bone, where in middle life it forms the redundancy called *double chin.* In marked contrast to the skin in front is that over the nape of the neck, where it is very dense and adherent to the sheaths of the muscles beneath, so that when the head is turned backward the skin is thrown into parallel transverse folds (Plate 22).

In close connection with the skin in front and at the sides of the neck is a thin layer of muscle tissue called the *platysma* (Plate 15, Fig. 5). This cutaneous muscle arises from the skin over the chin, the lower jaw and the cheek (page 38), and descends over the side of the neck to be inserted below the clavicle into the sub-cutaneous tissue over the pectoralis major and deltoid muscles.

Action of the platysma muscle.—The action of this muscle, owing to its interlacing with the depressor muscle of the lower lip (page 37), plays an important part in the expressions of *horror* and *extreme surprise* (Plate 17, Figs. 3 and 5.)

Within the meshes of the platysma muscle the *external jugular vein* appears when it holds its usual course in a line from the angle of the jaw to the middle of the clavicle. The blue outline of this vein is almost always perceptible in life, through the skin and it is especially pronounced during the acts of declaiming, singing, and coughing: also when the breath is held and any great effort is made, the external jugular veins, as well as those of the forehead, become swollen. In rage and strong passionate excitement, when the muscles of the neck are in violent action, the superficial veins become distended with blood and are noticeable on the surface.

The sterno-cleido-mastoid muscle (Plate 15, Figs. 1 and 2, and Plate 20) receives its name from its attachments to the mastoid process of the temporal bone above and to the sternum and clavicle below. It is the great muscular landmark at the side of the neck. It arises by a thick round tendon from the top of the sternum, and by a broad flat tendon from the adjacent part of the clavicle. There is a variable interval between these origins; the fibres from both of them commingle about the middle of the neck where the muscle is especially strong. Toward the insertion it flattens out and is attached to the

mastoid process and contiguous part of the temporal bone, and the outer part of the upper curved line of the occipital bone. Close examination reveals that the sternal fibres overlap the clavicular.

Action of the sterno-cleido-mastoid muscles.—The peculiarities of the disposition of the fibres and their insertions explain the different actions of which these muscles are capable. Ordinarily the united action of the two sterno-cleido-mastoid muscles maintains the head in the erect position, with the face directed forward, but if the action of the sternal fibres is greatest, the head will be tilted backward, with the face upward (Plate 22), while if the action of the clavicular fibres predominates the head will be bowed forward. The action of the clavicular fibres is marked in raising the head when the body is in a recumbent position, while the actions of both portions may be demonstrated by resisted effort. The independent action of either one of these muscles draws the head obliquely to the same side while the face is turned toward the opposite shoulder (Plates 22 and 23.) When the head is fixed the sterno-mastoid muscles elevate the sternum in forced inspiration.

There are many small muscles in relation to the bones composing the skeleton of the neck which serve to move the several vertebræ upon each other, and aid the movements of the skull upon the top of the vertebral column. Those requiring consideration in this relation are the *longus colli* muscles which serve to bend the cervical vertebræ forward, and the *scalene* muscles, which either raise the thorax, as in deep inspiration, or, being fixed below, they can bend the cervical vertebræ forward, as in rising from the recumbent position. They are shown in Plates 27 and 35.

The deeper muscles at the back of the neck are the complexus (Plate 36), the splenious (Plate 36), the trachelo-mastoid (Plate 37), and the upper portion of the trapezius (Plate 35) on either side. They are described with the muscles of the back of the trunk, page 65.

The *surface forms* of the neck, caused by the muscles and varying with their action, are always more marked when there is an absence of fat in the subcutaneous fascia of this region. (Plates 23 and 107.)

PLATE 19.

Diagram of the skeleton of the neck (*from the right side*).

1. The mastoid process.
2. The spine of the first cervical vertebra.
3. The spine of the second cervical vertebra.
4. The spine of the third cervical vertebra.
5. The spine of the fourth cervical vertebra.
6. The spine of the fifth cervical vertebra.
7. The spine of the sixth cervical vertebra.
8. The spine of the seventh cervical vertebra.
9. The spine of the first thoracic vertebra.
10. The acromion process of the scapula.
11. The spine of the second thoracic vertebra.
12. The glenoid fossa of the scapula.
13. The dorsum of the scapula.
14. The hyoid bone.
15. The pomum Adami (Adam's apple).
16. The thyroid cartilage.
17. The cricoid cartilage.
18. The trachea.
19. The position of the œsophagus.
20. The position of the thyroid muscles.
21. The clavicle.
22. The manubrium.
23. The coracoid process.
24. The joint between the manubrium and the gladiolus.
25. The gladiolus of the sternum.


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PLATE 20.

Diagram of the muscles of the neck (*from the right side*).

1. The parotid gland.
2. The spine of the second cervical vertebra.
3. The spine of the third cervical vertebra.
4. The trapezius muscle.
5. The spine of the fourth cervical vertebra.
6. The spine of the fifth cervical vertebra.
7. The spine of the sixth cervical vertebra.
8. The spine of the seventh cervical vertebra.
9. The complexus muscle.
10. The acromion process of the scapula.
11. The outer tuberosity of the humerus.
12. The masseter muscle.
13. The duct of the parotid gland.
14. The buccinator muscle.
15. The masseter muscle.
16. The hyoid bone.
17. The thyroid cartilage.
18. The sterno-mastoid muscle.
19. The cricoid cartilage.
20. The sternal portion of the sterno-mastoid muscle.
21. The sternal end of the clavicle.
22. The trapezius muscle.
23. The manubrium of the sternum.
24. The coracoid process of the scapula.
25. The joint between the manubrium and gladiolus of the sternum.
26. The pectoralis minor muscle.

PLATE 20

PLATE 21.

Fig. 1. Diagram of the deeper structures of the neck.

1. The styloid process.
2. The spine of the Atlas vertebra.
3. The posterior portion of the digastric muscle.
4. The spine of the second cervical vertebra.
5. The hyoid bone.
6. The skin at the nape of the neck.
7. The œsophagus.
8. The trapezius muscle.
9. The spine of the sixth cervical vertebra.
10. The spine of the seventh cervical vertebra.
11. The first rib.
12. The second rib.
13. The upper lateral nasal cartilage.
14. The lower lateral nasal cartilage.
15. The anterior portion of the digastric muscle.
16. The thyroid cartilage.
17. The Adam's apple (pomum Adami).
18. The crico-thyroid muscle.
19. The cricoid cartilage.
20. The sterno-thyroid muscle.
21. The thyroid body.
22. The clavicle.
23. The manubrium of the sternum.

Fig. 2. Diagram showing a vertical section of the head, face and neck.

1. The skull.
2. The dura mater.
3. The cortical surface of the cerebrum.
4. The medulla oblongata.
5. The cerebellum.
6. The uvula of the soft palate.
7. The pharynx.
8. The arytenoid cartilage.
9. The thyro-artenoid muscle.
10. The ligamentum nuchæ.
11. The spinal cord.
12. The spine of the vertebra prominens.
13. The frontal sinus.
14. The superior nasal meatus.
15. The middle nasal meatus.
16. The inferior nasal meatus.
17. The hard palate.
18. The upper incisor teeth.
19. The lower incisor teeth.
20. The tongue.
21. Section through the lower jaw.
22. The genio-hyoid muscle.
23. The hyoid bone.
24. The thyroid cartilage.
25. The crico-thyroid muscle.
26. The cricoid cartilage.
27. The trachea.
28. The œsophagus.

N. B.—The section (in Fig. 2) is not through the brain, the outer surface of which is represented.

PLATE 21

Fig. 1.

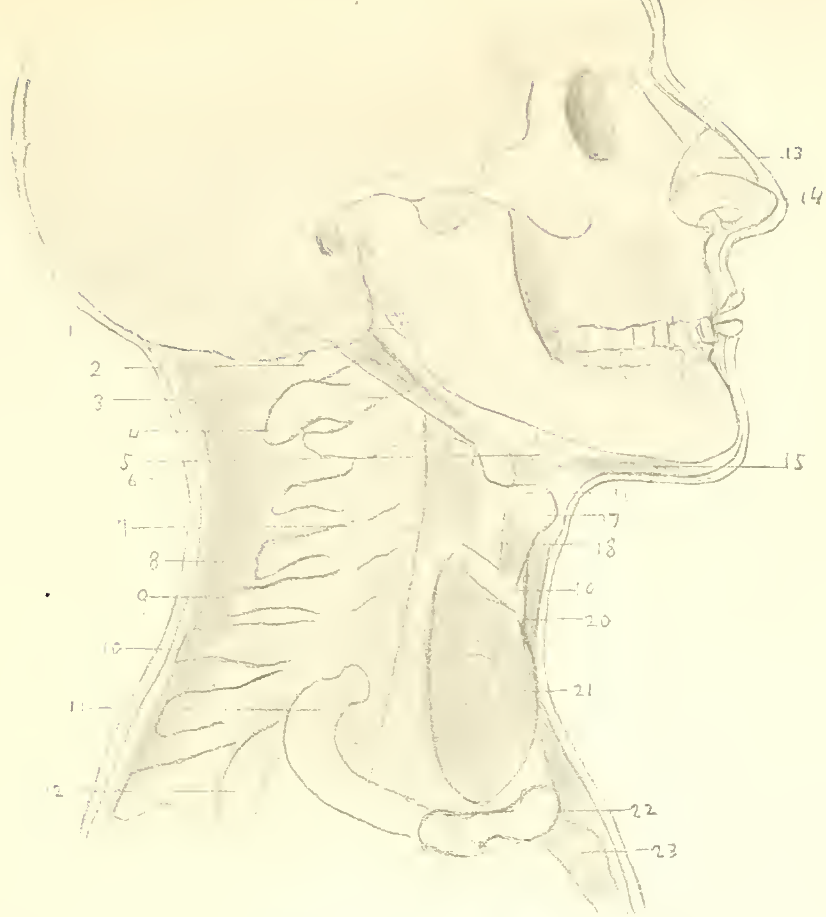

Fig. 2.

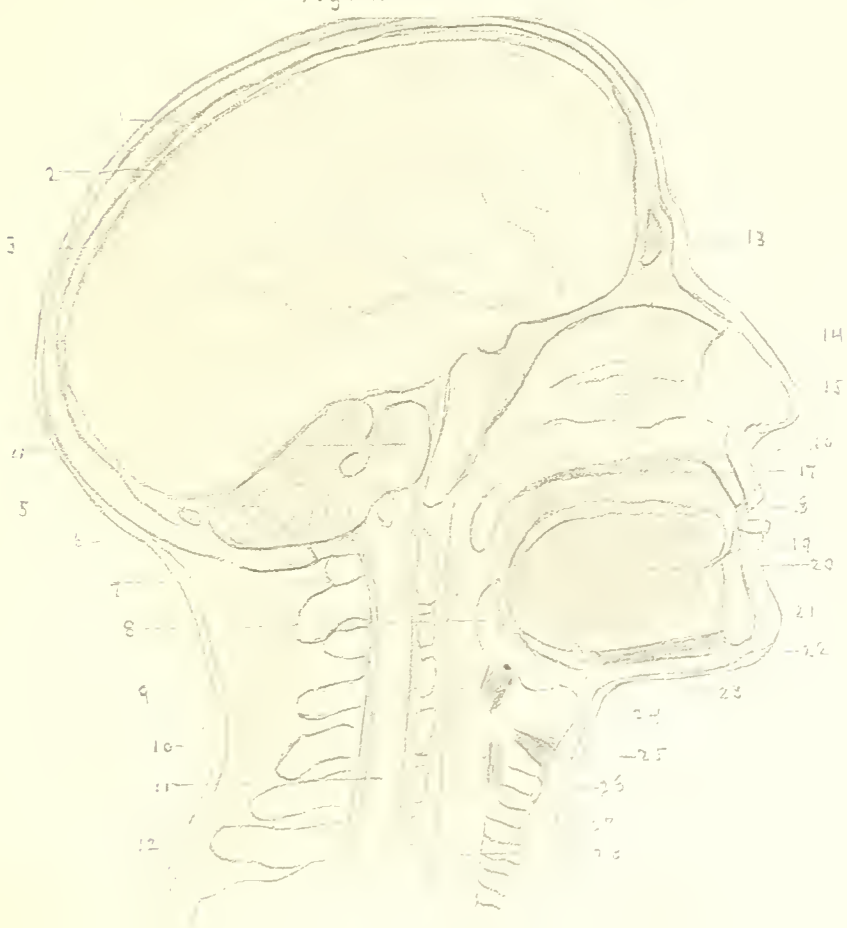

PLATE 22.

Fig. 1. Photograph of the head and shoulders of a woman with the arms raised to show the axillary folds.

Fig. 2. Photograph of the head and shoulders of a woman with the arms depressed to show the root of the neck.

Fig. 3. Photograph of a girl's head bent backward to show the sterno-mastoid muscle (*from the left side*).

Fig. 4. Photograph of a girl's head bent backward to show the neck (*from the front*).

PLATE 22

Fig. 1

Fig. 2

Fig. 3

Fig. 4

THE TRUNK.

THE *trunk* consists of the thorax, the abdomen, and the pelvis, connected by the spinal column.

The *spinal column* or backbone (Plates 24 and 25) is composed of thirty-three vertebræ which are irregular bones, superimposed upon one another.

The upper twenty-four vertebræ are separated, during life, by disks of *fibro-cartilage* and are called the true or movable vertebræ, in distinction to the lower nine which are the false or fixed vertebræ because they are consolidated into the sacrum and coccyx (page 90). The *intervertebral fibro-cartilages* fulfill the double object of contributing elasticity, and, acting as buffers, to prevent shocks to the spinal cord.

The entire column examined from the front (Plate 25) and from behind (Plate 33) shows that the seven vertebræ composing the skeleton of the neck gradually diminish in width to the topmost of the twelve vertebræ of the thorax, which are broader above than below, and that the five vertebræ of the loins successively widen and become thicker as they approach the sacrum. Viewed from the side (Plate 24) the column presents certain normal curves which contribute toward its flexibility. In the neck, the component vertebræ curve forward: in the thorax, backward; in the loins, forward, and in the sacrum and coccyx, backward. The average length of the spinal column in the well-formed adult male is about twenty-seven and three-quarter inches, and in the female about twenty-seven inches. Of this, five and one-half inches are made up of the cartilaginous disks between the vertebræ.

When the skeleton of the trunk is examined from the back (Plate 33) it will be seen that the haunch bones project considerably beyond the sacrum so that the hollow on each side of the vertebral spine is very deep in this locality. Above the loins in the thoracic region the hollows become shallower and broader because of the articulation of the ribs to the vertebræ. The hollows are filled by the erector spinæ mass of muscles on each side (Plate 37). When these muscles are in powerful contraction, as when a heavy weight is being

supported from above, they bulge outwardly, elevating the tendinous portions of the more superficial muscles, and the spines of the column are then in a median furrow. This is marked when the body is bent backward (Plate 23). On the contrary, when the body is bent forward, the median furrow disappears and the vertebral spines become more or less prominent.

The movements of the spinal column should be carefully observed as they are of great interest and importance. The normal curves, already mentioned, are forward in the neck, backward in the thorax, forward in the loins and backward in the pelvis. Movements forward are called flexions; backward, extensions. They are most free in the neck and in the loins. In the thoracic portion of the spine the movements are limited by the cage-like construction of the thorax. The ribs in front and the vertebral spines behind offer mechanical interference. The normal curves are modified when the body is flexed or extended to its greatest limit, but they are never entirely obliterated (Plate 23).

The spinal column is also capable of being moved laterally. In the neck this is very free (Plate 22). In the thoracic and lumbar portions it is very slight (Plate 23) unless the pelvis is shifted so as to cause an inclination of the sacrum, which is the base of the column.

All the vertebræ consist of anterior portions, *the bodies*, which, with the disks of cartilages, form a flexible support for the head and trunk, and of posterior portions, *the arches*, which, with their ligaments, form the protective canal which encloses the spinal cord (Plate 21). It is not necessary here to dwell upon the various vertebræ except as to those features of them which contribute to the mechanical construction of the trunk. The vertebræ of the neck (cervical) are shown in Plates 11 and 38 and described on page 43.

PLATE 23.

Fig. 1. Photograph of a man standing with the feet together and the trunk turned forcibly to the left.

Fig. 2. Photograph of a man standing with the feet in same position as Fig. 1 and the trunk turned forcibly to the right.

Fig. 3. Photograph of a man standing with the body bent backward and the arms extended, showing the curvature at the loins and the folds of the arm-pit, on the right side.

Fig. 4. Photograph of a man standing and stooping forward with the arms extended to show the curvature of the back.

PLATE 23 A

Fig. 1

Fig. 2

PLATE 23 B

Fig. 3

Fig. 4

PLATE 24.

Fig. 1. Photograph of the skeleton of the head, neck and trunk (*right side*).

1. The parietal bone.
2. The temporal bone.
3. The occipital bone.
4. The mastoid process.
5. The second cervical vertebra.
6. The fourth cervical vertebra.
7. The fifth cervical vertebra.
8. The sixth cervical vertebra.
9. The vertebra prominens.
10. The first thoracic vertebra.
11. The first rib.
12. The glenoid fossa of the scapula.
13. The inferior angle of the scapula.
14. The eighth rib.
15. The ninth rib.
16. The tenth rib.
17. The eleventh rib.
18. The second lumbar vertebra.
19. The crest of the ilium.
20. The coccyx.
21. The sciatic notch.
22. The tip of the coccyx.
23. The ischium.
24. The frontal bone.
25. The superciliary ridge.
26. The malar bone.
27. The angle of the lower jaw.
28. The clavicle.
29. The manubrium of the sternum.
30. The acromion process of the scapula.
31. The coracoid process of the scapula.
32. The third rib.
33. The fourth rib.
34. The fifth rib.
35. The sixth rib.
36. The promontory of the sacrum.
37. The anterior superior spine of the ilium.
38. The acetabulum.

Fig. 2. Diagram of the muscles of the head, face, neck and trunk (*right side*).

1. The galea capitis.
2. The temporal muscle.
3. The occipital muscle.
4. The trapezius muscle.
5. The splenius muscle.
6. The complexus muscle.
7. The omo-hyoid muscle.
8. The trapezius muscle.
9. The posterior portion of the deltoid muscle.
10. The infra-spinatus muscle.
11. The teres minor muscle.
12. The teres major muscle.
13. The trapezius muscle.
14. The triceps muscle.
15. The lumbar fascia.
16. The gluteus maximus muscle.
17. The frontal muscle.
18. The pyramidal muscle.
19. The orbicularis palpebrarum muscle.
20. The compressor naris muscle.
21. The zygomatic muscle.
22. The orbicularis oris muscle.
23. The masseter muscle.
24. The levator menti muscle.
25. The depressor anguli oris muscle.
26. The digastric muscle.
27. The omo-hyoid muscle.
28. The sterno-thyroid muscle.
29. The sternal portion of the sterno-cleido-mastoid muscle.
30. The clavicular portion of the sterno-cleido-mastoid muscle.
31. The external portion of the deltoid muscle.
32. The anterior portion of the deltoid muscle.
33. The pectoralis major muscle.
34. The insertion of the deltoid muscle.
35. The biceps muscle.
36. The external oblique muscle.
37. The umbilicus.
38. The olecranon process of the ulna.
39. Poupart's ligament.

fig. 1.

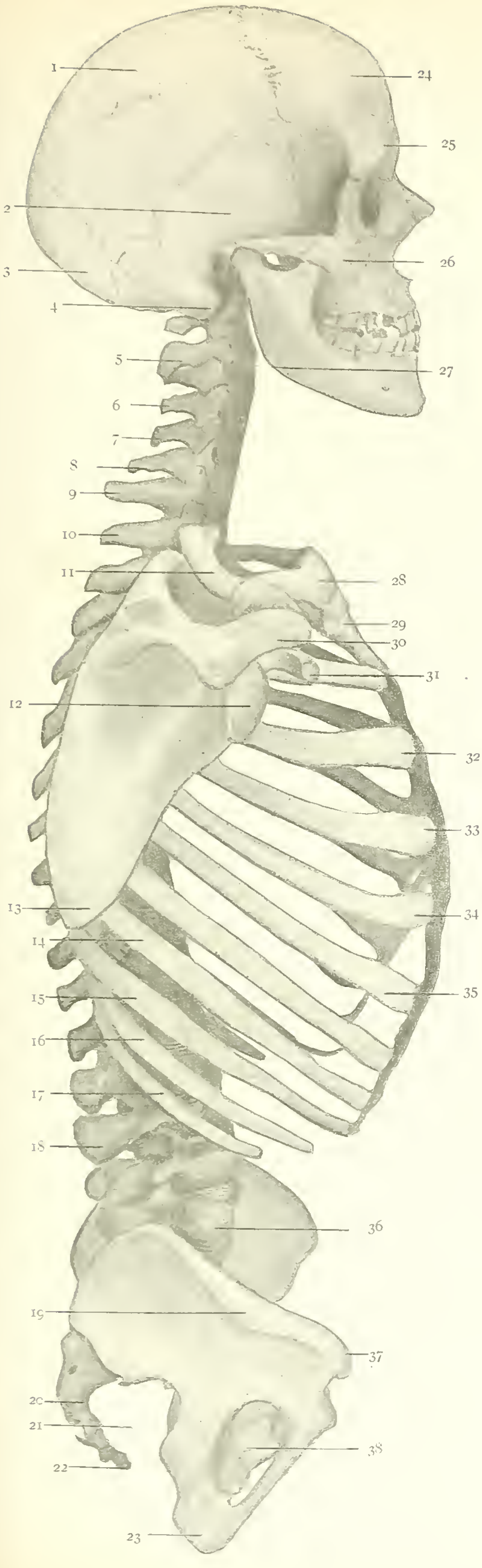
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fig. 2.

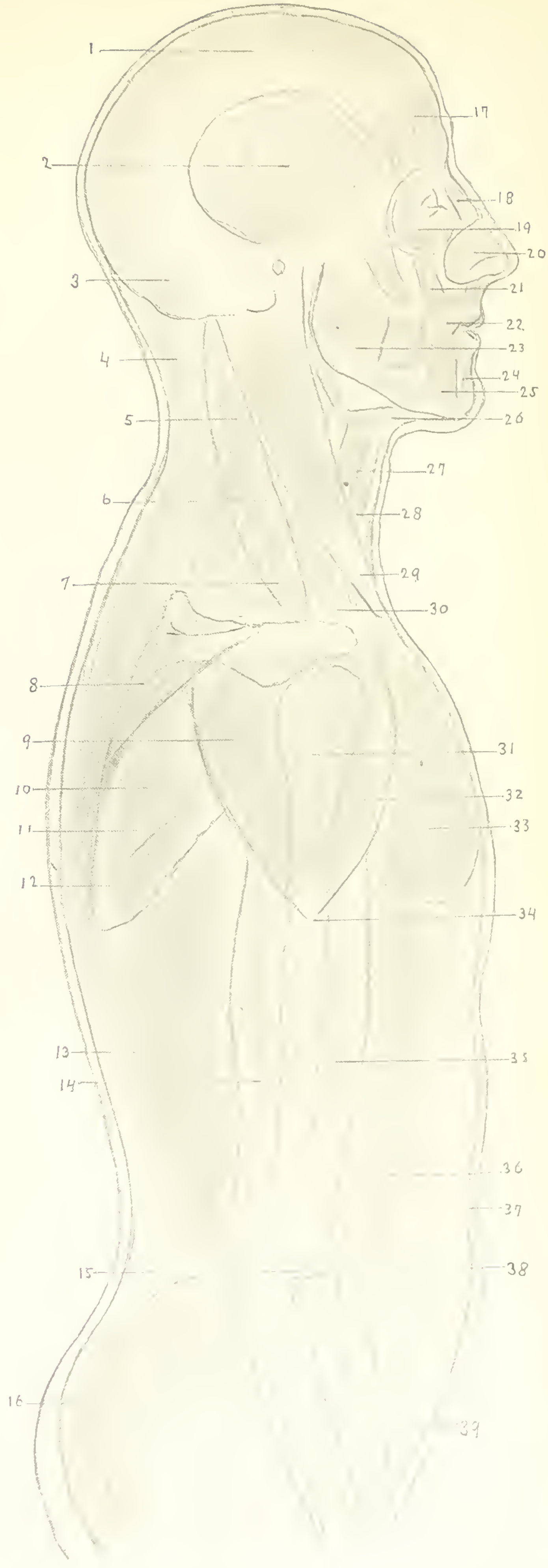
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PLATE 25.

Photograph of the skeleton of an European male, aged 33 years (*from the front*).

1. The frontal bone.
2. The right superciliary ridge.
3. The right supra-orbital arch.
4. The nasal bones.
5. The right temporal bone.
6. The right malar bone.
7. The suture between the two superior maxillary bones.
8. The mastoid process of the right temporal bone.
9. The angle of the inferior maxillary bone.
10. The chin.
11. The body of the fourth cervical vertebra.
12. The right first rib.
13. The right clavicle.
14. The coracoid process of the right scapula.
15. The glenoid process of the right scapula.
16. The cartilage of the right second rib.
17. The gladiolus of the sternum.
18. The right fourth rib.
19. The cartilage of the right fifth rib.
20. The ensiform cartilage.
21. The right sixth rib.
22. The right seventh rib.
23. The second lumbar vertebra.
24. The fourth lumbar vertebra.
25. The promontory of the sacrum.
26. The anterior superior spine of the right ilium.
27. The anterior inferior spine of the right ilium.
28. The right acetabulum.
29. The symphysis pubis.
30. The right ischium.
31. The external angular process of the left orbit.
32. The left temporal bone.
33. The vomer.
34. The left malar bone.
35. The mastoid process of the left temporal bone.
36. The angle of the inferior maxillary bone.
37. The sixth cervical vertebra.
38. The left first rib.
39. The left clavicle.
40. The manubrium of the sternum.
41. The coracoid process of the left scapula.
42. The body of the left scapula.
43. The left third rib.
44. The left fourth rib.
45. The cartilage of the left fifth rib.
46. The left sixth rib.
47. The left twelfth rib.
48. The left seventh rib.
49. The third lumbar vertebra.
50. The left ilium.
51. The sacrum.
52. The anterior superior spine of the left ilium.
53. The coccyx.
54. The left ischium.

PLATE 25

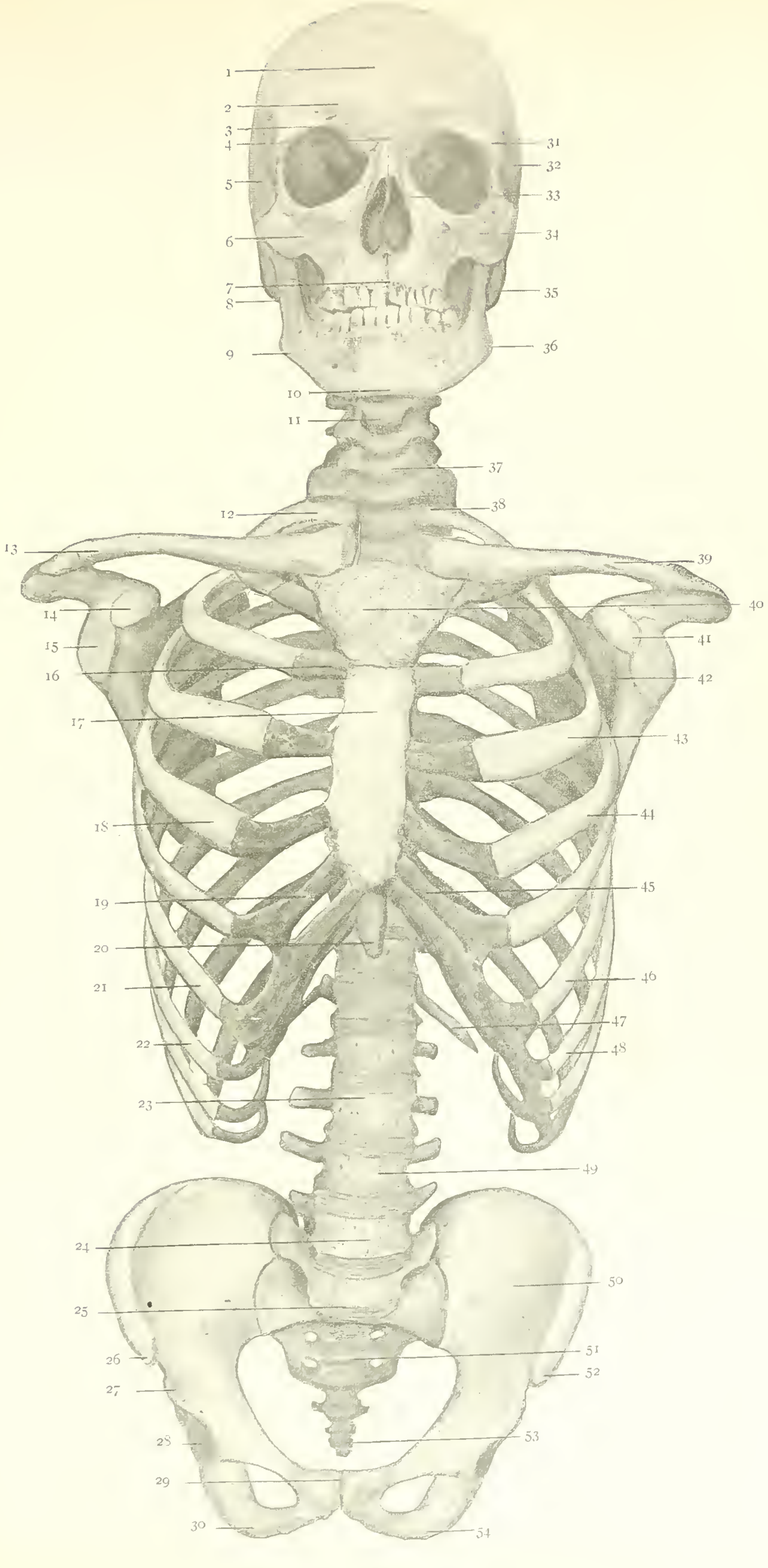

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PLATE 26.

Diagram of the superficial muscles of the front of the Torso.

1. The upper part of the right omo-hyoid muscle.
2. The clavicular portion of the right sterno-mastoid muscle.
3. The right sterno-thyroid muscle.
4. The right trapezius muscle.
5. The lower portion of the right omo-hyoid muscle.
6. The sternal end of the right sterno-mastoid muscle.
7. The right clavicle.
8. The position of the coracoid process of the right scapula.
9. The clavicular portion of the pectoralis major muscle.
10. The right deltoid muscle.
11. The insertion of the right pectoralis major muscle.
12. The right pectoralis major muscle.
13. The right biceps muscle.
14. The insertion of the right deltoid muscle.
15. The right serratus magnus muscle.
16. The right external oblique muscle of the abdomen.
17. The linea alba.
18. The right linea semi-lunaris.
19. The umbilicus.
20. The position of the anterior spine of the right ilium.
21. The right tensor vaginæ femoris muscle.
22. The right ligament of Poupart.
23. The sheath of the pyramidal muscles of the abdomen.
24. The position of the head of the right femur.
25. The upper portion of the right rectus femoris muscle.
26. The position of the greater trochanter of the right femur.
27. The position of the right ischium.
28. The position of the lesser trochanter of the right femur.
29. The right sartorius muscle.
30. The fascia lata.
31. The right adductor magnus muscle.
32. The position of the shaft of the right femur.
33. The sternal portion of the left sterno mastoid muscle.
34. The clavicular portion of the left sterno mastoid muscle.
35. The left sterno-thyroid muscle.
36. The left trapezius muscle.
37. The sternal end of the left sterno-mastoid muscle.
38. The left clavicle.
39. The position of the coracoid process of the left scapula.
40. The position of the head of the left humerus.
41. The left deltoid muscle.
42. The insertion of the left pectoralis major muscle.
43. The insertion of the left deltoid muscle.
44. The left biceps muscle.
45. The left serratus magnus muscle.
46. The left upper linea transversa.
47. The left middle linea transversa.
48. The left external oblique muscle of the abdomen.
49. The left lower linea transversa.
50. The anterior superior spine of the left ilium.
51. The left ligament of Poupart.
52. The left tensor vaginæ femoris muscle.
53. The left spermatic cord.
54. The position of the symphisis pubis.
55. The position of the great trochanter of the left femur.
56. The position of the left ischium.
57. The left adductor longus muscle.
58. The left sartorius muscle.
59. The fascia lata.
60. The left adductor magnus muscle.
61. The position of the shaft of the left femur.

THE THORAX.

THE *skeleton of the thorax* is composed of the sternum, the ribs and costal cartilages, and the thoracic vertebræ, so arranged as to form a conical movable framework, which gives attachment to the muscles of respiration and affords protection to the heart and lungs (Plate 31, Fig. 1).

The sternum, or breast-bone (Plate 38, Figs. 10 and 11), consists of three flat portions which, taken together, form a long, narrow, bony mass, shaped somewhat like an old Roman sword. The upper portion (*manubrium*) resembles the handle, the central portion (*gladiolus*) is blade-like, and the lower pointed process, usually cartilaginous, is the point (*enciform process*). The point is very variable in form and frequently bent to one or other side. The sternum in the adult male usually measures eight inches and in the female seven inches. The outer surface is slightly convex and the inner concave. Looked at from the side (Plate 24, Fig. 1), the outer surface of the different portions will be seen to occupy different planes, so that there is always a slight bend at the junction of the upper and middle pieces. The latter joint presents a ridge which can always be felt, and is therefore a *landmark*. It corresponds to the attachment of the cartilages of the two second ribs (Plate 25). The median line of the sternum is not continuous with the median line of the abdomen (page 60), but inclines rather to the right.

The ribs are twelve pairs of flattened bony hoops which are attached to the spinal column between the neck and the loins, so arranged that they project anteriorly and describe a series of arches which increase in length to the seventh, and in obliquity to the ninth, from above downward. The obliquity of the ribs is so great that the sternal end of any rib is on a level with the vertebral end of a rib considerably below it in numerical order (Plate 24, Fig. 1). Thus the sternal end of the first rib corresponds to the vertebral end of the fourth rib; that of the fifth to the ninth; and that of the ninth to the eleventh.

The seven upper ribs have separate cartilaginous prolongations which connect them with the sternum and are called *true* or *sternal* ribs, whereas the lower five are *false* or *asternal* ribs, because they are not joined directly with the sternum. The eighth, ninth and tenth ribs have cartilaginous prolongations which unite and turn upward to join the cartilage of the seventh rib (Plate 25), so that they are brought indirectly in connection with the sternum. The eleventh and twelfth are without cartilages and terminate in free ends in the muscular walls of the abdomen, and hence are called *floating* ribs.

The vertebral end of a rib is called its *head*. The narrow portion beyond the head is called the *neck*. The shaft or *body* of each rib from the seventh to the tenth (Plate 33) at a short distance from its neck suddenly bends forward and changes the direction of its curve. This is indicated upon its outer surface by an oblique ridge called the *angle*, which upon each successive rib downward is situated further outward. The sternal portions of the ribs are broader and thicker than the vertebral ends. The sternal ends are cupped for the reception of the cartilages which connect them with the sternum.

Each rib is peculiarly modified in conformation to its position in the series, and from the first to the last they are so remarkably adapted to the movements of respiration that the slight rotation which can take place only at their vertebral articulation occasions not only a slight elevation of their sternal ends, but an eversion of their lateral surfaces, so that by their united action the thoracic cavity is enlarged in every direction. The costal cartilages contribute greatly to the elasticity of the thorax.

The method of the articulation of the ribs with the thoracic vertebræ behind and with the sternum through their cartilages in front, is one of the most ingenious pieces of mechanism in nature, which not only permits the unceasing momentary alterations in the capacity of the thoracic cavity during respiration, but also fulfils the function of support and protection.

The intercostal spaces in relation to the sternum are wider above than below. They all vary with the expansion of the chest in respiration, and they can be increased upon one side when the body is bent over to the

opposite side. The skeleton of the human thorax is somewhat flattened in front and behind, so that it is broader than it is deep, and consequently the *supine* position is naturally an easy one to man.

The intercostal spaces are filled by the *intercostal muscles* (Plate 32), of which there are two separate layers, an internal and an external, the short fleshy fibres of which cross one another. The external intercostal muscles commence at the back and pass obliquely from the outer border of the rib above to the top of the rib below throughout the series, and extend as far forward as the costal cartilages. The internal intercostal muscles commence at the sternum and pass obliquely in the opposite direction to the external muscles, from the inner edge of the rib above to the upper border of the rib below, as far backward as the angles of the ribs.

Action of the intercostal muscles.—These muscles are chiefly in action in the movements of the ribs in ordinary tranquil breathing.

The thoracic vertebræ have their bodies thicker in front than behind, and the intercostal cartilaginous disks in this region are also similarly proportioned, so that the series permit the natural convex curvature backward. They are especially peculiar for their articulation with the ribs and for the length and obliquity of their spinous processes. There is much variability in the form of the thorax at all periods of life, and very commonly there is a want of symmetry in the two sides, the circumference of the right being greater than the left and probably due to the more frequent use of the right arm. In early childhood the thorax is relatively smaller than in the adult. The ribs are flatter and less hooped, and up to the end of the third year breathing is more *abdominal* than thoracic, while after that age in boys, and in men, too, it is effected by the action of the muscles attached to the lower seven ribs as well as the diaphragm (page 58). In adult females the upper portion of the thorax is less compressed from before backward, and the upper ribs are naturally brought more into play, even when not influenced by artificial pressure from the use of stays or corsets, so that in women breathing is chiefly *thoracic*. Comparison of the thorax in man and in woman (Plates 2 and 4) shows that it is more slightly constructed and relatively shorter and more rounded in the latter than in the former.

The muscles of the thorax are the pectoralis major and minor in front, the serratus magnus at the side, and the serrati postici major and minor (page 66) at the back.

The pectoralis major muscle (Plate 27) is the large triangular fleshy mass situated at the front of the chest, consisting of two special portions, the fibres of which converge toward the shoulder. The *clavicular portion* arises from the front of the inner half of the clavicle, and the joint between that bone and the top of the sternum, and extends obliquely outward, when the arm is at the side of the body, to the insertion of the deltoid muscle on the shaft of the humerus. The *sternal portion* arises by tendinous fibres from the front of the sternum, interlacing with those from the opposite muscle, and from the cartilages of the five or six upper true ribs. The fibres radiate toward their insertion, being peculiarly disposed so that the lower fibres pass obliquely upward beneath the upper fibres and their relative position is reversed, the lower becoming the upper as they terminate in a flat tendon at the outer edge of the bicipital groove on the humerus, beneath the insertion of the clavicular portion. The anterior rounded border of the axilla, or arm-pit, is formed by the twist in the sternal portion of the pectoralis major muscle.

This muscle is remarkable for its tendency to separate into radial bundles, which led Leonardo da Vinci to mistake it for a series of muscles, as is shown in the careful drawings of it which he left among his anatomical studies.

Action of the pectoralis major muscle.—Its function is chiefly to draw the arm forward and to rotate it inward upon the chest. When the arm is raised it can draw it downward, or if the fixed point is above the two great pectoral muscles can assist in raising the trunk, as in climbing.

The pectoralis minor and *subclavius muscles* are beneath the pectoralis major (Plate 27). The former is a triangular muscle arising from the sternal end of the third, fourth, and fifth ribs and the aponeurotic expansion over the subjacent intercostal muscles. It is inserted into the coracoid process of the scapula.

Action of the pectoralis minor muscle.—The pectoralis minor muscle serves to draw forward and downward the scapula, thus depressing the shoulder.

The subclavius muscle is a rounded bundle of fibres which arise from the junction of the first rib and its cartilage, and is inserted into the under surface of the clavicle which it serves to depress.

The skin over the front of the thorax in relation to the great pectoral muscles is quite tense over the sternum, but at the sides is very freely movable. It is delicate and closely connected with the superficial fascia, in which there is always more or less fat in a well-nourished man or woman. There is, however, much variability in the surface forms which are distinctive of the sexes, and which should be attentively studied by the artist, especially the sculptor, who undertakes to represent this portion of the trunk, because it possesses great beauty when its conformation is commensurate with that of the general development of the body.

The mammary glands or breasts are situated in the fat over the lower borders of the great pectoral muscles. In man these glands are not developed, the nipples, having a slight areola of dark skin about them, indicating their rudimentary existence. The nipples in the adult male are usually opposite the fourth intercostal spaces, about four-and-a-half inches from the middle line, but their position cannot be definitely fixed. In men with dark skins hairs grow over the sternum and occupy the depression between the pectoral muscles.

In woman the breasts are always glandular, being developed according to the age and functional activity. They vary in size and shape, and as they are closely connected with the sheaths of the great pectoral muscles, they follow the movements of these muscles when the arms are raised. The two breasts are naturally separated from one another, according to the width of the thorax. When fully formed they appear as smooth, firm globes rising from the surface of the chest, over the lower borders of the great pectoral muscles, with the nipples directed forward and outward, so that they point away from each other (Plate 3, Fig. 1). The position of the nipples of the female breasts cannot hold any definite relation to the chest wall, because of the changes of the glandular structure in different instances. There is always a tinted area of the skin about the nipple, which is more marked in dark-skinned women than in fair ones. It should be noted that the breasts are

movable and accommodate themselves to the position of the body, being somewhat higher on the chest in the recumbent position and sinking by their weight when the erect posture is assumed.

There is a great difference in the breasts in the maiden, the matron and in an aged woman. In youth they are usually higher and of such consistence that they do not yield to gravity and conform to the general roundness of the neck and shoulders, while in the matron, owing to the secreting function of the glands, they are enlarged and produce a folding of the skin below them. In old age they appear either withered or loose and formless.

From these facts it will be understood that there is a marked contrast in the surface form of the chest in the male and female. In man, owing to the non-development of the mammary glands, the lower borders of the great pectoral muscle stand out, producing a square appearance and suggesting strength (Plate 1). In women the presence of the breasts induces a roundness which extends over the greater part of the anterior fold of the arm-pit, so that there is a curved outline, which contributes to grace and beauty of effect (Plate 3).

The serratus magnus muscle (Plate 28, Figs. 1, 2 and 3) forms the inner wall of the axilla or arm-pit and is the fleshy covering at the side of the chest. It arises by nine digitations from the upper eight ribs, there being two attached to the second rib, which are formed into upper and middle and lower portions. The fibres from these several portions pass to be inserted upon the anterior surface of the vertebral border of the scapula. (Plate 28, Fig. 2.)

Action of the serratus magnus muscle.—Its function is to draw the scapula forward around the chest wall, but when the scapula is steady it becomes a powerful inspiratory muscle. The serratus is one of the most important muscles for the art-student to comprehend, for it is more or less concerned in every movement of the upper extremity. When in *action,* these muscles can be recognized through the skin, appearing like fingers of a huge hand upon the sides of the chest wall. (Plates 28 and 79.)

PLATE 27.

Fig. 1. Diagram of the thorax (*from the front*) showing the greater and lesser pectoral, and the subclavius muscles.

1. The right first rib.
2. The right subclavius muscle.
3. The coracoid process of the right scapula.
4. The head of the right humerus.
5. The right second rib.
6. The bicipital groove on the right humerus.
7. The right pectoralis minor muscle.
8. The sternal end of the right third rib.
9. The right humerus.
10. The sternal end of the right fourth rib.
11. The position of the right nipple.
12. The right fifth rib.
13. The left levator anguli scapulæ muscle.
14. The left trapezius muscle.
15. The head of the left first rib.
16. The coracoid process of the left scapula.
17. The tendon of the left pectoralis minor muscle.
18. The bicipital groove on the left humerus.
19. The clavicular portion of the left pectoralis major muscle.
20. The tendon of the pectoralis major muscle.
21. The central portion of the pectoralis major muscle.
22. The lower portion of the pectoralis major muscle.
23. The tendon of the left latissimus dorsi muscle.

Fig. 1.—continued.

24. The position of the left nipple.
25. The enciform cartilage.
26. The cartilage of the left sixth rib.
27. The cartilage of the left tenth rib.

Fig. 2. Diagram of the deeper muscles of the front of the neck; the longus colli and scaleni muscles.

1. The base of the skull.
2. The right rectus capitis anticus major muscle.
3. The right scalenus medius muscle.
4. The right scalenus anticus muscle.
5. The longus colli muscle.
6. The right scalenus posticus muscle.
7. The sternal end of the right first rib.
8. The right second rib.
9. The right third rib.
10. The left rectus capitis anticus minor muscle.
11. The left rectus capitis lateralis muscle.
12. The upper portion of the left longus colli muscle.
13. The left scalenus medius muscle.
14. The lower portion of the left longus colli muscle.
15. The left first rib.
16. The manubrium of the sternum (cut through).
17. The left second rib.
18. The left third rib.

PLATE 28.

Fig. 1. Diagram of the front of the thorax, showing the attachments of the serratus magnus and the insertion of the coraco-brachialis, sub-scapularis and supra-spinatus muscles.

1. The right first rib.
2. The right supra-spinatus muscle.
3. The coracoid process of the right scapula.
4. The right serratus magnus muscle.
5. The venter of the right scapula.
6. The thoracic aponeurosis.
7. The right coraco-brachialis muscle.
8. The right serratus magnus muscle.
9. The enciform cartilage.
10. The cartilage of the right sixth rib.
11. The left sub-scapularis muscle.
12. The left serratus magnus muscle.
13. The cartilage of the left fourth rib.
14. The left serratus magnus muscle.

Fig. 2. The scapula drawn outward to show the attachments of the serratus magnus muscle.

1. The spine of the first thoracic vertebra.
2. The acromion process of the scapula.

Fig. 2.—continued.

3. The upper portion of the serratus magnus muscle.
4. The glenoid fossa.
5. The middle portion of the serratus magnus muscle.
6. The venter of the scapula.
7. The sixth rib.
8. The lower portion of the serratus magnus muscle.
9. The eleventh rib.
10. The twelfth rib.

Fig. 3. Same as Fig. 2, with the scapula in proper relation to the thorax.

1. The vertebra prominens.
2. The first rib.
3. The spinous process of the scapula.
4. The dorsum of the scapula.
5. The middle portion of the serratus magnus muscle.
6. The lower portion of the serratus magnus muscle.
7. The twelfth rib.

PLATE 28

Fig. 1

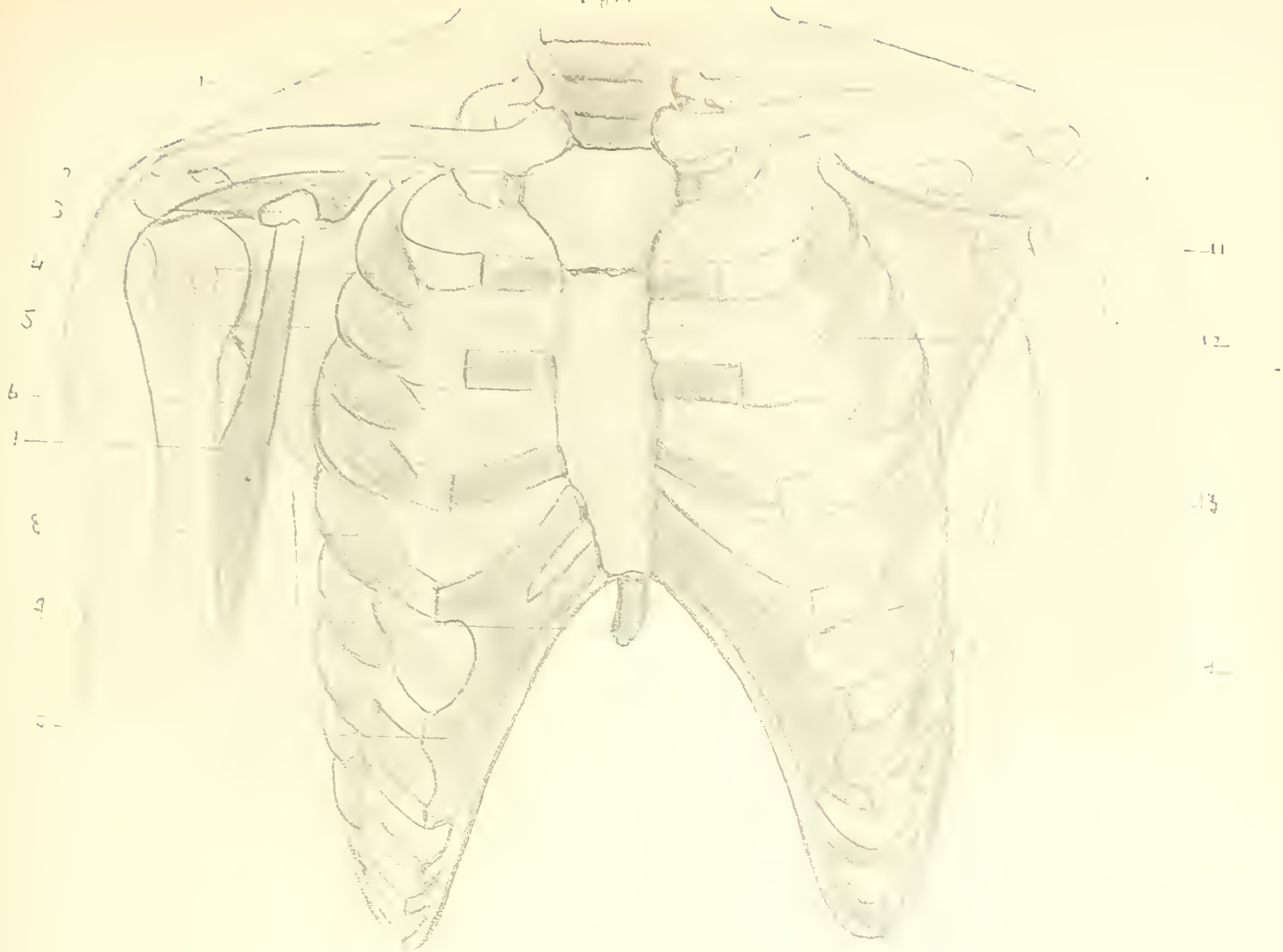


Fig. 2.

Fig. 3

THE ABDOMEN.

THE *abdomen* (Plate 31, Fig. 1) is the great cavity of the trunk which contains the stomach and intestinal canal, the liver, the spleen and the kidneys. It extends between the thorax above and the pelvis below. The sides of the abdomen, between the front and the loins, are called the flanks.

The *landmarks of the abdomen* (Plate 29, Fig. 1) are the prominences of the skeleton which can be felt through the skin in this region. The enciform cartilage indicates the upper limit of the abdominal cavity, and is deeply placed in the hollow between the cartilages of the seventh ribs. This hollow is always noticeable, and is the so-called "pit of the stomach." The anterior superior spinous processes of the ilia, commonly called the haunch bones are the outer limits of the abdominal cavity; they are always recognizable. The spinous processes of the pubic bones, where they join in front, the *symphysis*, are the lower limit of this region. They can only be readily ascertained in thin persons, for when they are covered with much fat they are proportionately obscured.

The abdomen is narrowest below the tenth ribs, where it is called the waist. The cavity of the abdomen is not limited by the above boundaries as indicated by the points of reference of the skeleton, for it extends upward a considerable distance beneath the ribs, its roof being formed by a dome-shaped partition called the diaphragm. (Plate 32, Fig. 1.) Owing to this deceptive formation of the abdominal cavity the important organs, the liver on the right side and the stomach on the left, are under cover of the lower ribs. (Plate 31, Fig. 1.)

The diaphragm (Plate 31, Fig. 1, and Plate 32, Fig. 1) separates the cavity of the thorax from the cavity of the abdomen. Its construction is very peculiar, as it consists of muscular and tendinous portions which arch upward and inward, converging to be inserted into a common central tendon. Its upper surface arches into the thoracic cavity at variable heights, being higher

on the right side than on the left (Plate 32, Fig. 1). Only the muscular portions at the sides are movable.

Action of the diaphragm.—In expiration it mounts upward, in inspiration it descends, pushing downward somewhat the abdominal viscera. It is concerned in *coughing, sneezing* and *laughing.*

Lessing, in his criticism of the Laocoön, draws attention to the depression at the pit of the stomach as evidence of the keen observation of the artist in exhibiting the action of the diaphragm in the combined mental and physical strain, for which that statue will always be one of the marvels of the art world.

The wall of the abdomen in front and at the sides is composed of several sheets of muscles, which are remarkably disposed so that they afford a movable protective covering to the contents of the abdominal cavity.

The muscles of the lateral abdominal wall (Plate 29, Fig. 3) are arranged in three strata and are named after the direction of their fibres: the external or descending oblique; the internal or ascending oblique, and the transversalis. The sheaths of these muscles are peculiar in their tendinous expansions in front, where they split and surround the recti muscles, extending on either side of the middle line from the sternum to the pubes.

The external oblique muscle is the largest, and arises from the lower seven ribs, interdigitating with the serratus magnus muscle (Plate 30, Fig. 2). The tendinous expansions from the external oblique muscles are remarkably developed toward the lower margins of the abdomen in the groins, where great strength is required to sustain the pressure of the viscera from within. Here they stretch in a curved manner from the anterior spines of the ilia to the pubic symphysis, forming thick borders which are the *femoral arches,* or the so-called *ligaments of Poupart.* These are important, because they constitute the boundary lines between the abdomen and the thighs (Plate 29, Fig. 1).

The internal oblique muscle (Plate 30, Fig. 1) is thinner than the external. It arises from the outer half of the inner border of Poupart's ligament, and from the crest of the ilium, and its fibres radiate upward to the lowermost four ribs.

The transversalis muscle arises from the inner surface of the six lower costal cartilages, interdigitating with the diaphragm, and from the crest of the ilium. Its fibres pass across the abdomen as far as the *linea semilunaris.* The latter on each side is formed by the blending of the sheaths of the transversalis and oblique muscles at the borders of the recti muscles (Plate 30, Fig. 1).

The recti muscles (Plates 26 and 30) are in front, separated from each other by the *linea alba*, which is formed by the blending of the sheaths of the two muscles and corresponds to the median furrow of the abdomen. Each muscle arises from the pubes, and as it ascends broadens to the outer surfaces of the cartilages of the fifth, sixth and seventh ribs. The recti muscles are crossed by three transverse tendinous intersections which constitute the *lineæ transversæ*. The upper one of these is opposite the enciform cartilage, the lower one at the umbilicus, and the intermediate one midway between the others. The furrows on the surface corresponding to these linea transversæ are always conspicuous when the muscles are in action.

The pyramidales muscles (Plate 30, Fig. 2) are two little triangular-shaped muscles arising from the pubes in front of the origins of the recti muscles.

Action of the abdominal muscles.—The cross direction of the fibres of the abdominal muscles serves to strengthen the walls of the abdomen and in a measure suggests their functional action. Acting together they support and protect the abdominal viscera. They are quiescent in inspiration, but in expiration they assist by drawing the lower ribs downward when the spinal column is fixed. If the pelvis is fixed the muscles of both sides co-operate to bend the thorax forward, and when those of one side act alone they bend the trunk to that side. The oblique muscles cause rotation of the trunk: the external oblique turning the face to the opposite side, and the internal oblique turning it to the same side. This is seen in *mowing*, when the right external oblique and the left internal oblique are simultaneously brought into action. In *climbing*, the abdominal muscles, acting from the thorax, draw upward the pelvis.

The chief action of the recti muscles is concerned in raising the body from a recumbent position. Their peculiar segmentation and enclosure in so

firm a sheath, as above described, enables them to maintain their actions in all possible bendings of the body. (Plates 23 and 101.)

The skin over the abdomen is more adherent to the subjacent parts at the middle line than elsewhere, and is most firmly attached at the groins. It is very delicate and sensitive above the umbilicus. In the male it is usually darker in color in the middle line and it is provided with fine hairs directed downward. In the female the hairs are only over the pubes. The fat in the superficial fascia of this region varies greatly in amount. It is always greater in the lower part, and it is sometimes enormous.

The umbilicus, or navel, is the cicatrix resulting from the obliteration of the cord at birth which connected the child with the mother. It is peculiarly different in the two sexes, being shallow and small in the male, and deep and wide in the female (Plates 1 and 3). In the adult when standing erect (Plate 1, Fig. 1), the umbilicus is about opposite the disk between the third and fourth lumbar vertebræ. It varies somewhat in proportion to the obesity or laxity of the abdominal wall. It is always below the centre of the middle line extending from the enciform cartilage to the pubes. At the age of two years it occupies the exact mid-point of the body, measured from head to foot. Earlier than this it is below the centre and in later life above it. It is an important point of reference, and, therefore, it should be noted that in the adult, in either sex, it is situated three-quarters of an inch above a line drawn from one iliac crest to another at their highest points.

The surface form of the front of the abdomen is irregular and it should be noted that the depressions correspond to the subjacent tendinous intersections, being strongly contrasted with the bulging of the fleshy parts of the muscles (Plate 30).

The most conspicuous of the surface depressions are the *median furrow* which extends from the enciform cartilage of the sternum to a point midway between the umbilicus and the pubes and the *right and left lateral furrows* which curve slightly from the costal cartilages of the tenth rib along the outer borders of the recti muscles. The median furrow corresponds to the subjacent linea alba and the lateral furrows to the linea semilunaris. When the body is erect the recti muscles usually present two uniform masses situated between

these furrows (Plate 1, Fig. 1), but when they are brought into action by bending the body forward or backward (Plate 23) three transverse furrows are produced on each side; the upper one of which is at the cartilage of the eighth rib and the lower one at the umbilicus, while the middle one appears middle way between them. They refer to the linea transversea or tendinous intersections in the recti muscles (Plate 30). These transverse furrows become especially marked when the body is raised from the recumbent position or when the body is tense from the effort of lifting, or bent in the action of supporting great weight from above. On this account they should be strongly indicated in typical figures designed as Caryatides.

The muscles of the posterior wall of the abdomen are the *quadratus lumborum*, the *psoas* and the *iliacus* muscles.

The quadratus lumborum muscles (Plate 43, Fig. 1) extend from the crest of the ilium to the last rib at the sides of the lumbar vertebra, and externally to the psoas muscles.

Action of the quadratus lumborum muscles.—The quadratus lumborum is peculiar for the cross direction of its fibres, which enable its action to steady the spinal column if acting from below, or the last rib if acting from above.

The psoas muscle (Plate 43, Fig. 2) is a large fleshy mass arising from the transverse processes and the lateral borders of the bodies of the last thoracic and upper four lumbar vertebræ. The muscle descends vertically to the brim of the pelvis, where it becomes tendinous and joins with the tendon of the iliacus muscle to be attached to the back of the lesser trochanter of the femur.

The iliacus muscle (Plate 43, Fig. 2) is fan-shaped and arises from the inner margin of the crest of the ilium, and its tendon blends with that of the psoas, so that practically the iliacus and psoas are one muscle.

Action of the iliacus and psoas muscles.—Their combined action serves to flex the hip-joint and to rotate the thigh outward. In the latter effort the base of support of the body is widened, so that it assists in maintaining the erect position.

PLATE 29.

Fig. 1. The landmarks of the region of the abdomen (*from the front*).

1. The enciform cartilage.
2. The right twelfth rib.
3. The position of the right linea semi-lunaris.
4. The position of the umbilicus.
5. The position of the linea alba.
6. The position of the right ligament of Poupart.
7. The left twelfth rib.
8. The position of the left linea semi-lunaris.
9. The position of the linea alba.
10. The position of the left ligament of Poupart.
11. The symphisis of the pubes.

Fig. 2. The landmarks of the region of the abdomen (*from the right side*).

1. The seventh rib.
2. The eighth rib.

Fig. 2.—continued.

3. The twelfth rib.
4. The ninth rib.
5. The eleventh rib.
6. The tenth rib.
7. The body of the fourth lumbar vertebra.
8. The enciform cartilage.
9. The umbilicus (navel).
10. The anterior superior spine of the ilium.

Fig. 3. Same as Fig. 2, with the muscles.

1. The lattisimus dorsi muscle.
2. The lumbar aponeurosis.
3. The triangle of Petit.
4. The serratus magnus muscle.
5. The enciform cartilage.
6. The end of the eighth rib.
7. The umbilicus (navel).
8. The external oblique muscle.
9. The crest of the ilium.

Fig. 1.

Fig. 2.

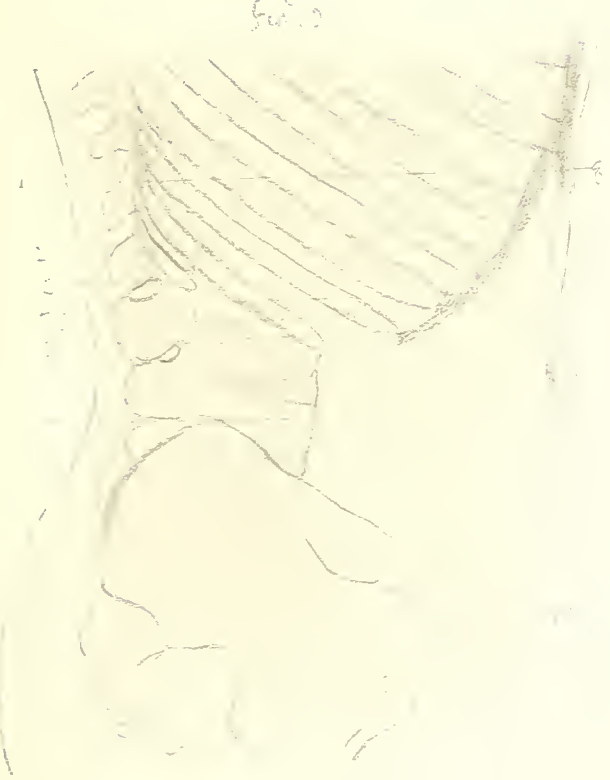


Fig. 3.

PLATE 30.

Fig. 1. Diagram of the deeper muscles of the anterior abdominal wall.

1. The attachment of the sheath of the right rectus muscle over the seventh costal cartilage.
2. The sheath of the rectus muscle.
3. The transversalis muscle.
4. The umbilicus.
5. The anterior superior spine of the ilium.
6. The right ligament of Poupart.
7. The symphisis pubes.
8. The upper portion of the left rectus muscle.
9. The middle of the left rectus muscle.
10. The linea alba.
11. The ascending or internal oblique muscle.
12. The sheath of the pyramidalis muscle.
13. The left ligament of Poupart.
14. The tendon of the internal oblique muscle.
15. The spermatic cord.

Fig. 2. Diagram of the superficial muscles of the abdominal wall.

1. The linea alba.
2. The upper linea transversa.
3. The linea alba.
4. The linea semilunaris.
5. The descending or external oblique muscle.
6. The tendon of the external oblique muscle.
7. The right pyramidalis muscle.
8. The ligament of Poupart.
9. The spermatic cord.
10. The sheath over the rectus muscle.
11. The position of the upper linea transversa.
12. The middle linea transversa.
13. The descending or external oblique muscle.
14. The umbilicus.
15. The tendon of the external oblique muscle.
16. The ligament of Poupart.
17. The symphisis pubis.
18. The spermatic cord.

Fig. 1.

Fig. 2

PLATE 31.

Fig. 1. Photograph of a male skeleton, with outline. The sternum and front portions of the ribs are removed and the viscera of the thorax and abdomen are inserted diagrammatically to show their relations to the diaphragm.

1. The upper lobe of the right lung.
2. The root of the heart.
3. The middle lobe of the right lung.
4. The lower lobe of the right lung.
5. The diaphragm.
6. The liver.
7. The gall bladder.

Fig. 1—continued.

8. The position of the vermiform appendix.
9. The bladder.
10. The upper lobe of the left lung.
11. The lower lobe of the left lung.
12. The apex of the heart.
13. The stomach.
14. The transverse colon.
15. The small intestines.

Fig. 2. Photograph of a male skeleton, without outline, to be compared with Fig. 1.

PLATE 31

Fig. 1

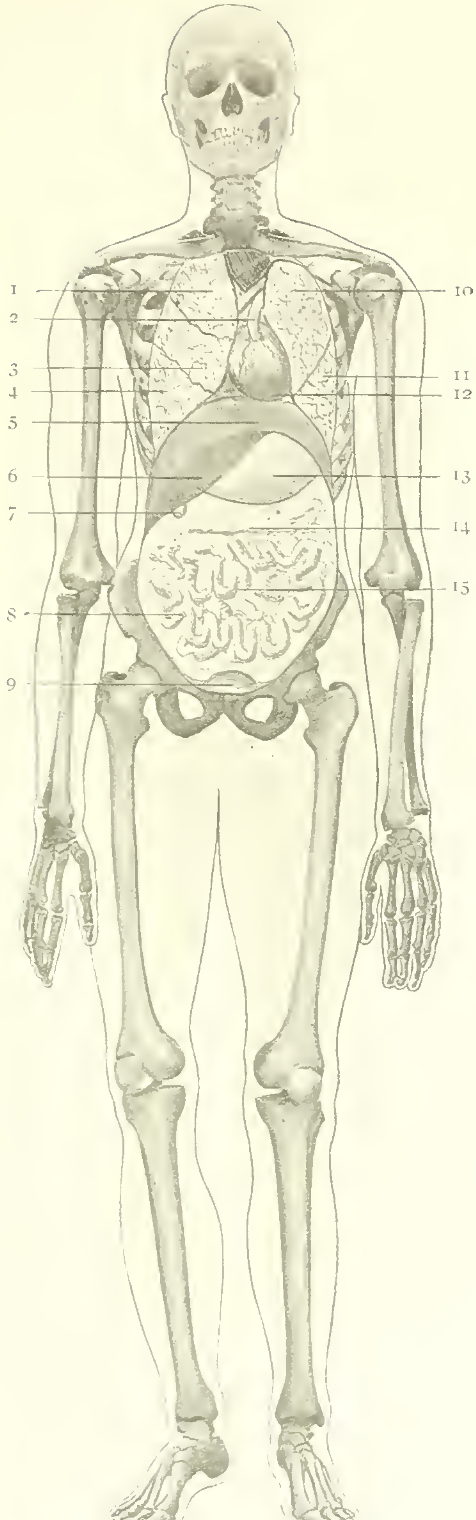


Fig. 2

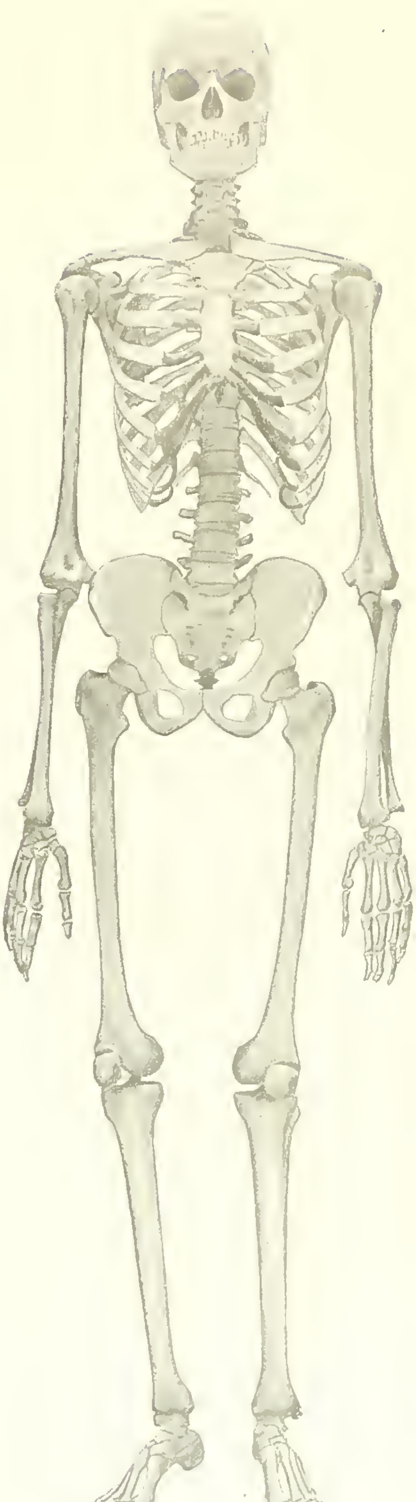


PLATE 32.

Fig. 1. Diagram showing the attachments of the diaphragm.

1. The right fifth rib.
2. The right arch of the diaphragm.
3. The enciform cartilage.
4. The right crus of the diaphragm.
5. The body of the third lumbar vertebra.
6. The right crus of the diaphragm.
7. The left fifth rib.
8. The left sixth rib.
9. The central tendon of the diaphragm, upon which the heart rests.
10. The left arch of the diaphragm.
11. The left crus of the diaphragm.
12. The attachment of the diaphragm on the body of the third lumbar vertebra.
13. The left crus of the diaphragm.

Fig. 2. Diagram showing the intercostal muscles.

1. The right first rib.
2. The right second rib.
3. The external intercostal muscles between the second and third ribs.
4. The external intercostal muscle between the third and fourth ribs.
5. The external intercostal muscles between the fourth and fifth ribs.
6. The external intercostal muscles between the fifth and sixth ribs.
7. The left first rib.
8. The left second rib.
9. The internal intercostal muscle between the second and third ribs.
10. The internal intercostal muscle between the third and fourth ribs.
11. The internal intercostal muscle between the fourth and fifth ribs.
12. The internal intercostal muscle between the fifth and sixth ribs.

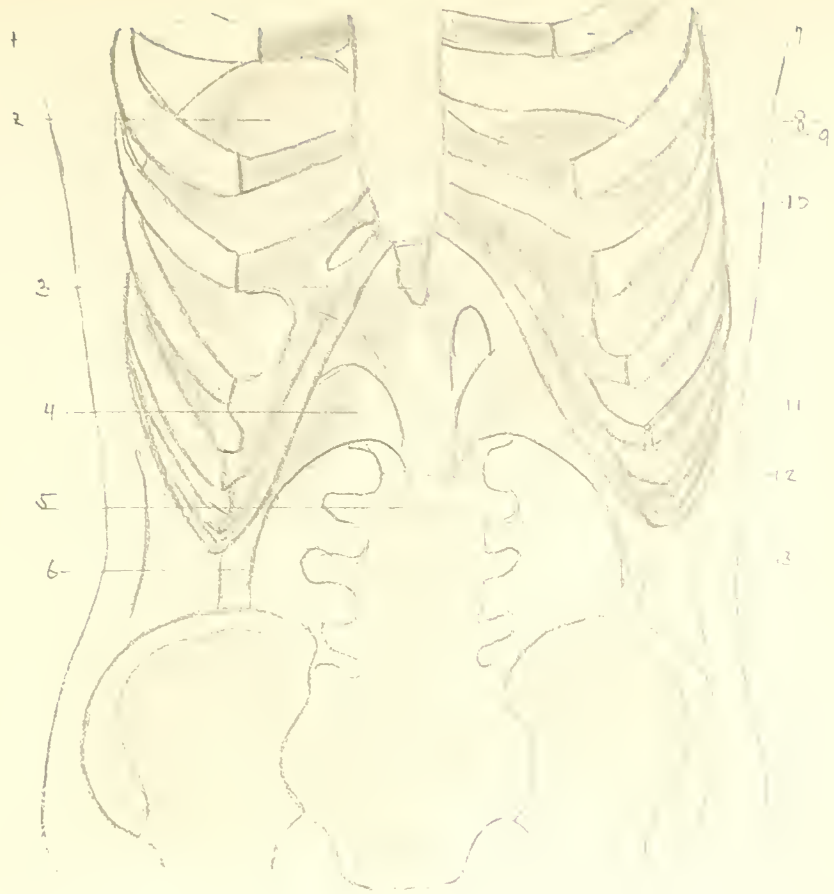
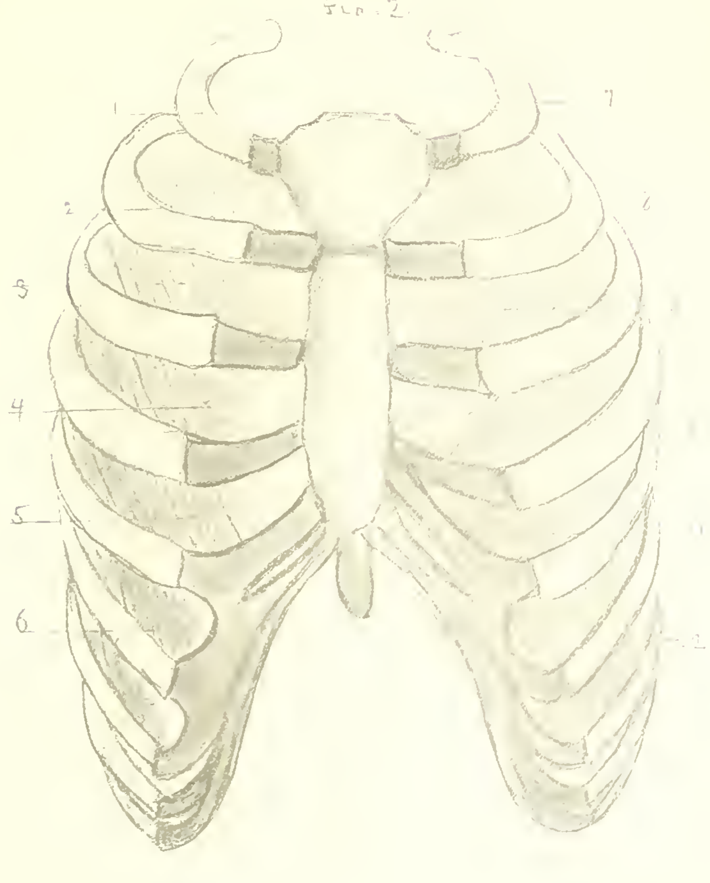


Fig. 2.



THE BACK.

THE *back* properly extends from the occiput to the sacrum, and the entire vertebral column is therefore the skeleton of this region (Plate 33). Examination of the column shows that the spines of the series of vertebræ are not exactly in a straight line. There is very often a divergence to the right in the thoracic portion, caused by the greater use of the right arm than of the left. The most conspicuous of the vertebral spines are that of the seventh cervical and that of the first thoracic, and those of the lumbar region. The latter have an intimate connection with the overlying structures which produces well-marked surface dimplings.

The features of the special vertebræ belonging to the subdivisions of the neck, thorax and loins are shown on Plates 11, 25 and 38, and are described on pages 43, 53 and 90.

The relations which the scapulæ bear to the thorax should be carefully noted. The spinous processes of the scapulæ can be felt through the skin, and when the arms are crossed upon the chest they correspond to the level of the spine of the fourth thoracic vertebra and ascend outwardly to the points of the shoulders. The inferior angles of the scapulæ, when the arms are in the above position, are on the level of the spine of the seventh thoracic vertebra. In the movements of the upper extremities, the vertebral borders of the scapulæ hold very different relations to the spinal column, and when the shoulders are thrown back, with the arms at the sides, the inferior angles in the adult are about three inches apart; whereas, when the arms are crossed upon the chest, the interval between them measures about twelve inches, and this may be increased to sixteen inches by raising the arms above the head.

The muscles of the back are arranged in several layers. The superficial muscles are the trapezius and latissimus dorsi muscles which overlie the deeper layer, consisting of the splenius, the complexus and levator anguli

scapulæ at the back of the neck, and the rhomboideus, the serratus postici superior and inferior, and the erector spinæ mass at the back of the trunk.

The trapezius muscle (Plate 35, Fig. 1) arises from the inner portion of the superior curved line on the occipital bone, from the spinous processes of the vertebra prominens and all the thoracic vertebræ. Each trapezius muscle is triangular in shape, but the two together form a trapezoid. The fibres of each muscle converge from their extensive origin toward the shoulder. Those from the spines of the vertebræ are inserted upon the upper border of the spinous process of the scapula, exactly corresponding to the origin of the deltoid muscle on the lower border (page 75). The fibres from the occipital bone pass downward and curve outwardly, to be inserted into the upper margin of the clavicle. (Plate 27, Fig. 1.)

Action of the trapezius muscle.—When both trapezii muscles act from below they draw the head backward, or one muscle acting in the same way will turn the head backward to the corresponding side. The whole of each muscle can raise the shoulder by retracting the scapula.

The latissimus dorsi muscle (Plate 36) arises on each side from the lower six thoracic spines, under cover of the trapezius muscle (Plate 31), and from the upper two spines of the sacrum and the adjacent crest of the ilium and passes to be inserted by a flat tendon one-and-a-half inches broad, into the floor of the bicipital groove of the humerus (Plate 34). The fibres twist on themselves as they converge toward the axilla, and curving over the inferior angle of the scapula, are so disposed at their insertion that the fibres from the upper portion become the lowest in the groove, and the fibres from the lower portion the highest. This muscle is usually attached by a special aponeurotic expansion to the inferior angle of the scapula, which, together with its origin beneath the trapezius muscle, serves to keep the scapula in relation to the chest wall in the movements of the upper extremity. The tendons of the latissimus dorsi and teres major muscles form the posterior fold of the axilla or arm-pit.

Action of the latissimus dorsi muscle.—This muscle draws the arm inward and backward, co-operating with the pectoralis major muscle, but if the arm

is the fixed point, as in climbing, the latissimus dorsi muscle assists in raising the trunk.

The splenius muscle (Plate 15) arises from the spines of the upper six thoracic vertebræ and vertebra prominens, and divides into two portions, the inner of which (splenius capitis) is inserted into the mastoid process of the temporal bone and upon the curved line of the occipital bone, beneath the sterno-mastoid muscle, and the outer portion (splenius colli) is inserted into the transverse processes of the upper three cervical vertebræ.

Action of the splenius muscles.—The two splenii muscles assist the two sterno-mastoid muscles; acting together, they hold the head erect. The action of either of them (the two portions working together) is to draw the head and the upper cervical vertebra toward its own side.

The complexus muscle (Plate 36) is beneath the trapezius and splenius muscles. It is very thick and powerful, and arises from the transverse processes of the lower cervical and upper thoracic vertebræ. It is inserted into the depression between the two curved lines on the occipital bone. This muscle is separated from its fellow by the *ligamentum nuchæ*, which consists of fibro-elastic tissue extending along the spines of all the cervical vertebræ, except the Atlas, to the occipital protuberance. In man it is the rudiment of the strong elastic ligament which enables some of the lower animals to sustain the weight of the head (page 44). At the outer side of the complexus are the trachelo-mastoid and transversalis-colli muscles. These muscles are the continuations to the head and neck of the erector spinæ mass of muscles (Plate 37).

The levator anguli scapulæ muscle (Plate 35, Fig. 1) arises from the transverse processes of the four upper cervical vertebræ, and descends along the side of the neck and is inserted into the superior angle of the scapula.

Action of the levator anguli scapulæ muscle.—It has the power of raising the scapula, as in shrugging the shoulders.

The rhomboideus muscle (Plate 35, Fig. 1) is exposed when the trapezius muscle is removed. It sometimes consists of two portions called the *major*

and *minor.* It arises from the vertebræ prominens, and the spines of the five upper thoracic vertebræ, and is inserted into the vertebral border of the scapula, a tendinous arch being interposed between that bone and the lower portion of the muscle.

Action of the rhomboideus muscle.—It draws the scapula backward and upward, antagonizing the serratus magnus muscle,

The serratus posticus superior muscle (Plate 36, Fig. 1) is beneath the rhomboideus, which arises from the ligamentum nuchæ and the spines of the vertebræ prominens and the upper two thoracic vertebræ. It passes obliquely downward to be attached to the second, third, fourth and fifth ribs beyond their angles.

Action of the serratus posticus superior muscle.—It elevates the upper ribs.

The serratus posticus inferior muscle is under the latissimus dorsi. It is larger than the superior, and arises from the lumbar fascia and the spines of the two upper lumbar vertebræ, and is attached to the four lower ribs beyond their angles.

Action of the serratus posticus inferior muscle.—It depresses the lower ribs, thereby expanding the thoracic cavity and enabling the diaphragm (page 58) to assist in expiration.

The *lumbar fascia* (Plate 34) or *aponeurosis* is the dense sheath over the deeper muscles of the back and the loins. The latter are called the *erector spinæ mass of muscles* and are exposed upon the removal of the lumbar fascia as is shown in Plate 37. This fleshy mass occupies the groove on the side of the lumbar spines, and arises from the posterior part of the iliac crest from the sacrum and lumbar vertebræ, and ascends to the level of the twelfth ribs, where it subdivides into the *longissimus dorsi* and *ilio-costalis muscles.* The longissimus is the largest portion and is inserted into the transverse processes of all the thoracic vertebræ and the lower borders of the eight lower ribs. It is continued in the neck with the transversalis colli muscle (Plate 37).

The ilio costalis consists of fibres which ascend outwardly to be inserted into the angles of the lower nine ribs.

Beneath the longissimus dorsi muscle are the *semi-spinalis* and *multifidus* muscles (Plate 37) which are a series of little fleshy slips extending from each vertebra to the one above it, from the sacrum to the second cervical vertebræ. In the thoracic part of the back there are also short transverse muscles, the *rotatores*.

Action of the erector spinæ mass of muscles.—The action of the erector spinæ mass of muscles can be well shown when the erect position is slowly resumed after the body has been bent forward, especially if a heavy weight be lifted at the same time (Plate 42.)

The *skin of the back* is closely adherent to the superficial fascia which is dense and tough, and in the well-nourished individual contains much fat.

It has been stated in the description of the curvatures of the spinal column (page 52) that in bending the body forward or backward, or sideways (Plate 23) the changes in the surface contours are chiefly due to the contractions of the erector-spinæ mass of muscles which show through the thinner layer of the more superficial muscles of the back, which for the greater part are tendinous in relation to the spinal column. It is upon the sides of the trunk, at the arm-pits and at the flanks, that the superficial muscles, the trapezii and latissimus dorsi, contribute to the outline.

The features referable to the development and action of the muscles in this region are always more pronounced in men than in women, because in women there is a greater amount of fat in the superficial fascia which masks the details of the surface marking. (Plate 5.)

The median furrow in the thoracic portion of the back (page 63) is naturally deepened by the drawing together of the scapulæ toward the middle line through the action of the trapezii muscles. (Plate 42).

The beauty in the back of a woman, which depends so much upon the softness and grace of outline, is demonstrated in several poses upon Plates 77, 83 and 86.

PLATE 33.

Photograph of the Skeleton of an European male, aged 33 years (*from the back*).

1. The occipital protuberance.
2. The spine of the first cervical vertebra (Atlas).
3. The spine of the fourth cervical vertebra.
4. The spine of the seventh cervical vertebra (prominens).
5. The spine of the first thoracic vertebra.
6. The left first rib.
7. The left clavicle.
8. The acromion process of the left scapula.
9. The coracoid process of the left scapula.
10. The spine of the left scapula.
11. The body of the left scapula.
12. The inferior angle of the left scapula.
13. The left eighth rib.
14. The left ninth rib.
15. The left tenth rib.
16. The left eleventh rib.
17. The left twelfth rib.
18. The crest of the left ilium.
19. The posterior spinous process of the left ilium.
20. The left ischium.
21. The right first rib.
22. The right second rib.
23. The superior angle of the right scapula.
24. The right third rib.
25. The spine of the right scapula.
26. The right fourth rib.
27. The body of the right scapula.
28. The right sixth rib.
29. The right seventh rib.
30. The inferior angle of the right scapula.
31. The right eighth rib.
32. The right ninth rib.
33. The right tenth rib.
34. The twelfth thoracic vertebra.
35. The right eleventh rib.
36. The right twelfth rib.
37. The right transverse process of the third lumbar vertebra.
38. The right ilium.
39. The sacrum.
40. The coccyx.

PLATE 33

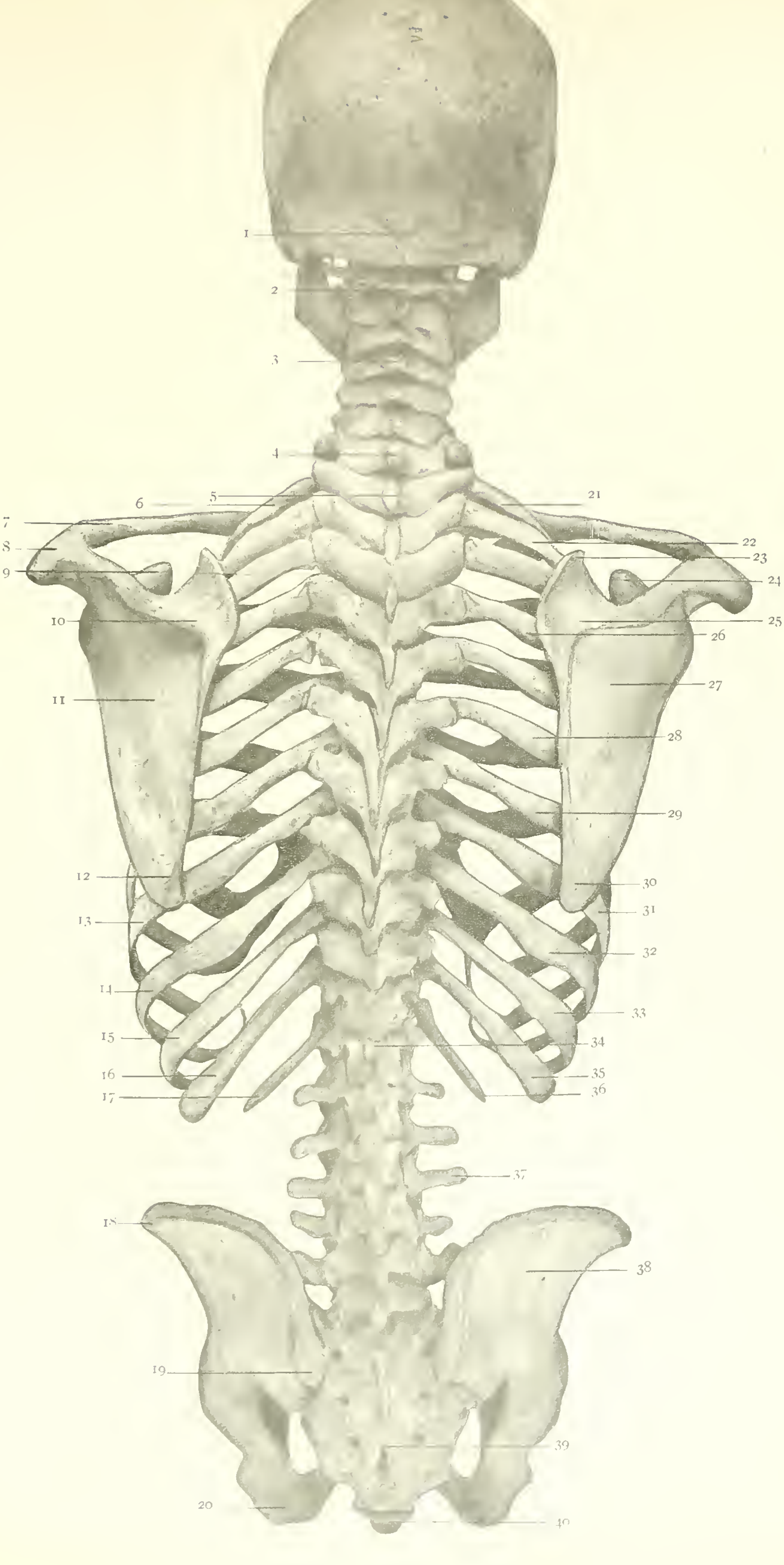

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PLATE 34.

Diagram of the superficial muscles of the back of the Torso.

1. The upper portion of the left trapezius muscle.
2. The left sterno-cleido-mastoid muscle.
3. The position of the vertebra prominens.
4. The acromion process of the left scapula.
5. The tendon of the teres major muscle.
6. The infra spinatis muscle.
7. The tendon of the left latissimus dorsi muscle.
8. The position of the inferior angle of the left scapula.
9. The left serratus magnus muscle.
10. The left latissimus dorsi muscle.
11. The lowermost attachment of the trapezii muscles over the spine of the twelfth thoracic vertebra.
12. The external oblique muscle of the abdomen.
13. The lumbar aponeurosis.
14. The crest of the ilium.
15. The gluteus maximus muscle.
16. The position of the great trochanter of the left femur.
17. The coccyx.
18. The lower border of the left gluteus maximus muscle.
19. The upper portion of the right trapezius muscle.
20. The sterno-mastoid muscle.
21. The acromion process of the right scapula.
22. The aponeurosis of the trapezius muscle.
23. The infra spinatis muscle.
24. The tendon of the right latissimus dorsi muscle.
25. The position of the inferior angle of the right scapula.
26. The serratus magnus muscle.
27. The latissimus dorsi muscle.
28. The external oblique muscle of the abdomen.
29. The posterior superior spinous process of the right illum.
30. The position of the great trochanter of the right femur.
31. The position of the tuberosity of the ischium.
32. The position of the lesser trochanter of the right femur.

PLATE 34

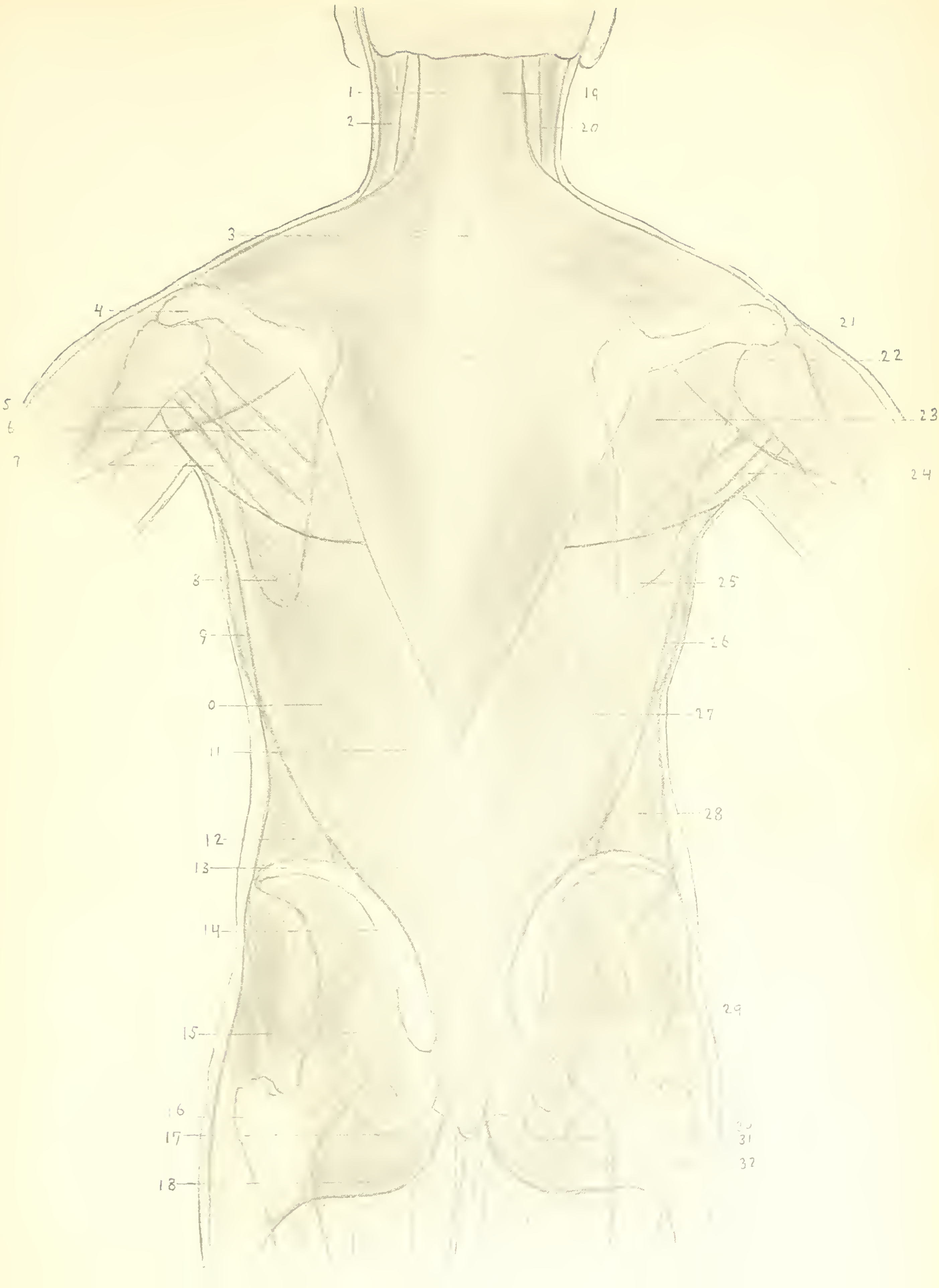

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PLATE 35.

Fig. 1. Diagram of the back of the thorax, showing the attachments of the trapezius muscle on the left side, and the levator anguli scapulae and rhomboideus major and minor muscles on the right side.

1. The cervical portion of the left trapezius muscle.
2. The spine of the seventh cervical vertebra.
3. The left trapezius muscle.
4. The acromion process of the left scapula.
5. The spine of the left scapula.
6. The dorsum of the left scapula.
7. The left serratus magnus muscle.
8. The left eighth rib.
9. The inferior angle of the left scapula.
10. The left ninth rib.
11. The left tenth rib.
12. The attachment of the trapezius muscle on the twelfth thoracic vertebra.
13. The left twelfth rib.
14. The tendons of the right levator scapulæ muscles.
15. The right levator scapula muscle.
16. The right clavicle.
17. The right rhomboideus minor muscle.
18. The right rhomboideus major muscle.
19. The right serratus magnus muscle.

Fig. 1—continued.

20. The right eighth rib.
21. The right ninth rib.
22. The right tenth rib.
23. The right eleventh rib.
24. The right twelfth rib.

Fig. 2. Diagram showing the attachments of the deeper muscles at the back of the neck.

1. The left rectus capitis posticus minor muscle.
2. The left obliquus capitis superior muscle.
3. The left rectus capitis posticus major muscle.
4. The left obliquus capitis inferior muscle.
5. The rotatores spinæ muscles.
6. The left first rib.
7. The inter-transversales muscles.
8. The right mastoid process.
9. The right obliquus capitis superior muscle.
10. The right rectus capitis posticus major.
11. The right obliquus capitis inferior muscle.
12. The spine of the seventh cervical vertebra.
13. The right first rib.
14. The right inter-transversales muscles.

PLATE 35

Fig. 1.

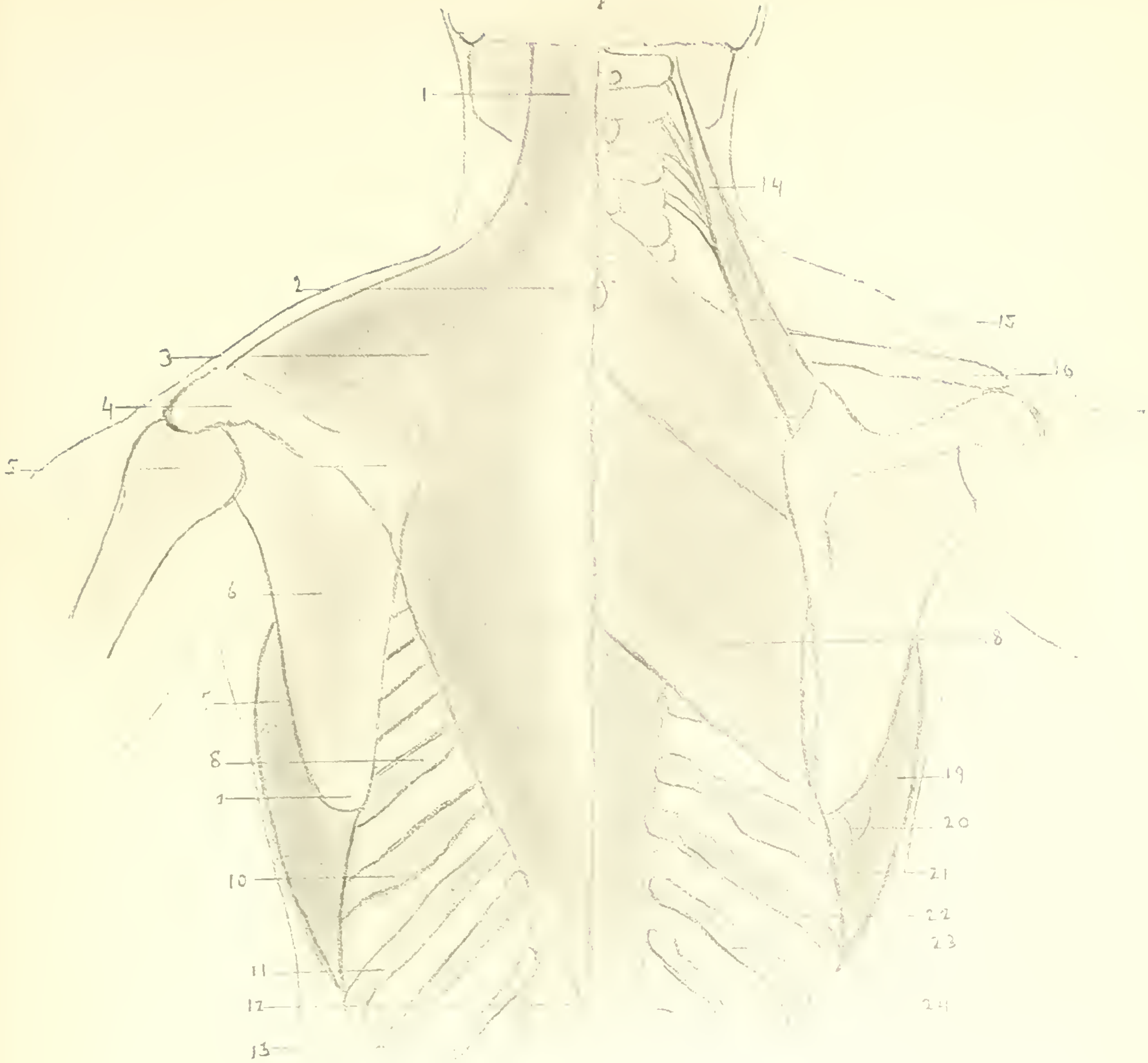

Fig. 2.

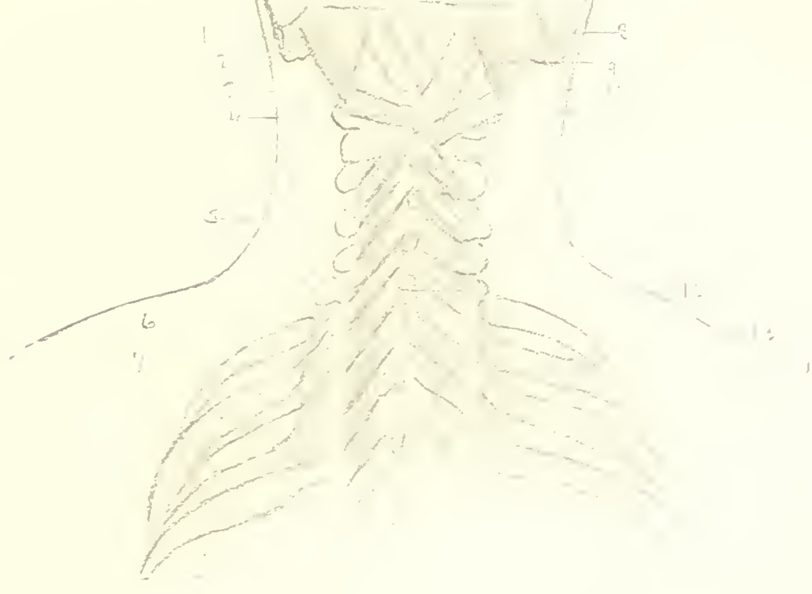

PLATE 36.

Diagram of the back of the trunk showing the attachments of the latissimus dorsi and complexus muscles on the left side, and the biventer cervicis and the serrati postici muscles on the right side.

1. The upper portion of the left complexus muscle.
2. The lower portion of the left complexus muscle.
3. The tendon of the left latissimus dorsi muscle.
4. The attachment of the latissimus dorsi on the spine of the eighth thoracic vertebra.
5. The left latissimus dorsi muscle.
6. The left external oblique muscle of the abdomen.
7. The triangle of Petit.
8. The coccyx.
9. The upper portion of the right biventer cervicis muscle.
10. The spine of the seventh cervical vertebra.
11. The right serratus posticus superior muscle.
12. The middle tendon of the biventer cervicis muscle.
13. The lower portion of the right biventer cervicis muscle.
14. The right ninth rib.
15. The right serratis posticus inferior muscle.


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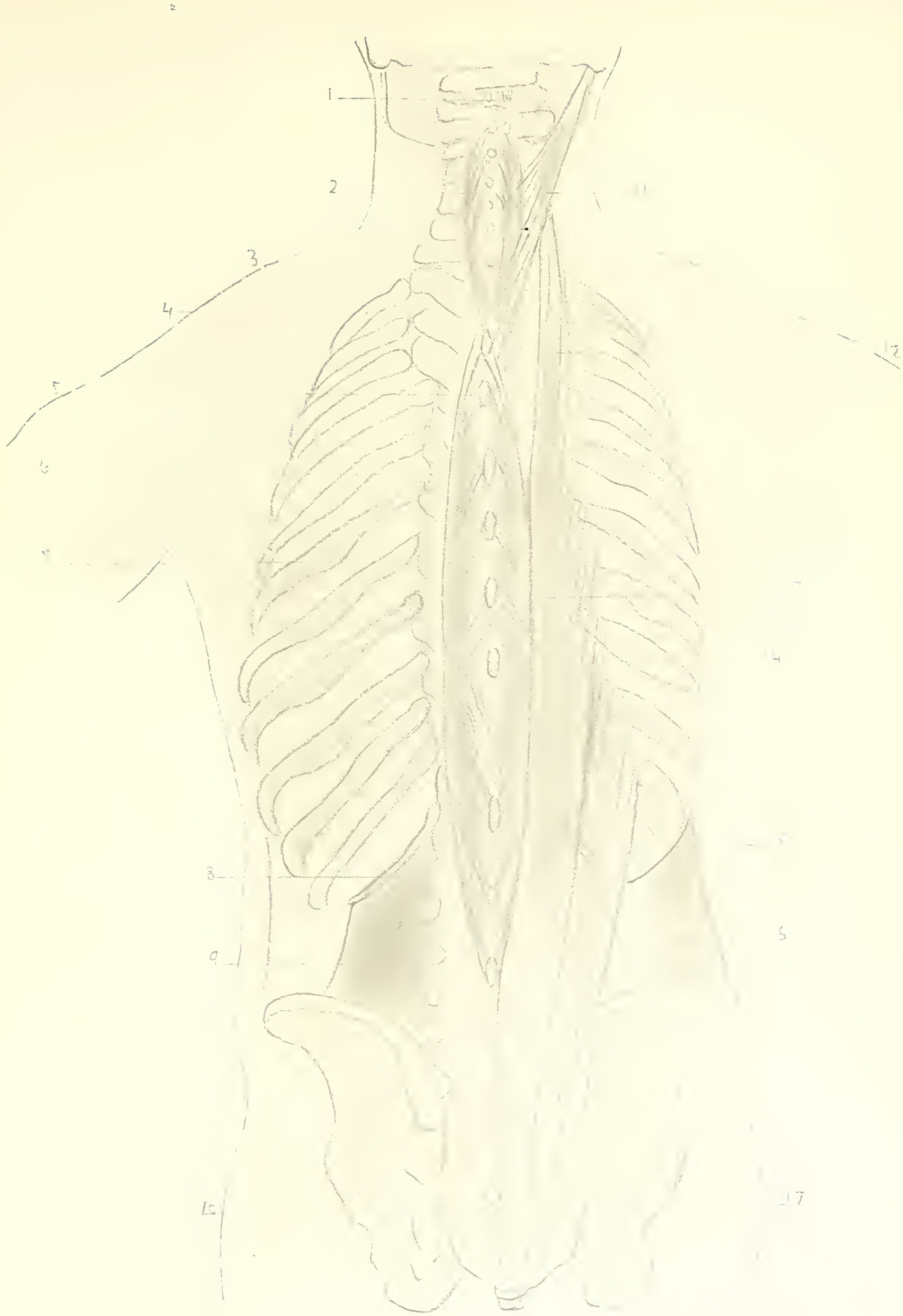
PLATE 37.

Diagram of the back of the trunk, showing the attachments of the deep spinal muscles on the left side, and the erector spinae mass of muscles on the right side.

1. The spine of the second cervical vertebra.
2. The left spinalis colli muscle.
3. The spine of the seventh cervical vertebra.
4. The left first rib.
5. The spine of the third thoracic vertebra.
6. The spinalis dorsi muscles.
7. The left sixth rib.
8. The left twelfth rib.
9. The left quadratus lumborum muscle.
10. The right erector spinæ mass of muscles
11. The right trachelo mastoid muscle.
12. The right cervicalis ascendens muscle.
13. The right longissimus dorsi muscle.
14. The right eighth rib.
15. The right sacral lumbalis muscle.
16. The right internal oblique muscle of the abdomen.
17. The erector spinæ mass of muscles.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THE UPPER EXTREMITY.

THE *skeleton of the upper extremity* (Plate 39, Figs. 1 and 2) consists of the clavicle, the scapula, the humerus, the ulna and the radius, the carpal, the meta-carpal and the digital bones.

The clavicles, or collar-bones (Plate 38, Figs. 4 and 5), are the long, irregular bones which extend outward over the first ribs to the shoulders, which they join with the outer processes of the scapulæ in forming. These bones are superficial throughout their greater extent, and should be carefully studied by the artist. In the female the clavicles are more slender than in the male. Their proportions depend upon the strain required of the muscles which are attached to them. The right clavicle is often shorter than the left. Each bone presents a peculiar S-shaped curvature, so that the anterior border begins by curving forward at the sternal end, and at the middle gradually curves backward to the shoulder, where it points outward. The posterior border is exactly the reverse. The degree of curvature of the inner portion is very variable, especially in men, and the freedom and much of the grace of movement of the upper extremity depend upon it. The sternal end is rough, thick and prominent, and rests upon a shallow depression in the upper border of the sternum. The joint at this locality is remarkable for the strength of the ligaments which secure it, and it is important to understand that this joint is the only direct connection of the skeleton of the upper extremity with the thorax. The outer end of the clavicle is rough, broad and flattened, where it is joined by strong ligaments to the scapula. The joints of the clavicle, with the sternum and scapula (Plate 7, Figs. 1, 2 and 3), are capable of very slight motion, but slight as this motion is, it is essential to the perfect freedom and harmonious movement of the upper extremity.

The scapulæ, or shoulder-blades (Plate 38, Figs. 1, 2, 3), are the triangular bones situated at the back of the upper part of the thorax, extending between

the second and seventh ribs. Each scapula consists mainly of a broad, flat plate, the body, with raised and roughened borders. The dorsal surface is smooth and slightly convex, while the inner surface is concave, adapting itself to the shape of the thorax. Upon the dorsal surface there is a prominent projection called the *spinous process*, which divides the upper third of the bone into two hollows called the superior and inferior spinous fossæ. The outward termination of the spine is called the *acromion process*, and forms, with the corresponding end of the clavicle, the summit of the shoulder. The upper border of the scapula ends in a projection called the *caracoid process*, which is curiously crooked and resembles the little finger half bent. It can be felt, during life, below the clavicle extending forward over the shoulder joint. The thickest part of the bone is at the anterior angle. It is called the *head*, and presents an oval shallow fossa, the *glenoid cavity*, for the reception of the head of the humerus. The central portion, or body of the scapula, is extremely light and presents various ridges both upon the surfaces and at the borders which afford attachment to the various muscles which take origin from this bone.

The clavicle and scapula are the framework of the shoulder proper, and, with those of the opposite side, form *the shoulder girdle* (Plate 38, Fig. 14). The girdle is incomplete posteriorly, owing to the gap between the two scapulæ, which are connected with the thorax solely by muscles, while in front the two clavicles are supported upon and connected with the top of the sternum by strong ligaments (page 51). The shoulder girdle is remarkable for its lightness and great mobility.

There is a marked difference in the way men and women naturally carry their shoulders, owing partly to the relative development of the muscles of the shoulder girdle and partly to the different form of the thorax in the two sexes. The broader the thorax the broader is the surface upon which the shoulder girdle is supported. In men who have been strong and well nourished since childhood the outer ends of the collar bones slope outward and upward, whereas in women both ends of the collar bones are either on the same level or they slope outward and downward.

The humerus (Plate 38, Figs. 6, 7, 8 and 9) is the single long bone of the arm. It presents a shaft, or body, and upper and lower ends, which are respectively adapted to the shoulder and elbow joints.

The upper end of the humerus consists of a smooth hemispherical *head* directed upward, and inward, and backward, when the arm is at the side of the body, to be received against the glenoid cavity of the scapula (Plate 7, Fig. 1). The constriction below the head is called the *neck.* From this the *greater tuberosity* extends outward. The latter is a rough prominence, and gives attachment to the supra-spinatus, infra-spinatus and teres minor muscles (Plate 41, Fig. 1). Another prominence, the *lesser tuberosity*, projects forward from the neck and receives the attachment of the sub-scapularis muscle. Between these tuberosities is a deep vertical furrow, the *bicipital groove*, for the accommodation of the long tendon of the biceps muscle (Plate 43, Fig. 1). Below the tuberosities the shaft of the humerus is cylindrical as far as the middle, where the outer side is roughened for the attachment of the powerful deltoid muscle. Below the latter point the shaft becomes prismatic and slopes downward and slightly forward to the lower end, where it becomes transversely flattened (Plate 38, Figs. 6 and 7).

The lower end of the humerus has in its central part the *trochlea*, which is smooth, rounded, and constricted at the middle, so that the inner portion is somewhat larger, and projects lower than the outer. In front there is above the constriction a depression, the *coronoid fossa*, for the coronoid process of the ulna when the forearm is flexed. Behind, there is a similar depression, the *olecranon fossa*, for the olecranon process of the ulna when the forearm is extended. Jutting out from the external part of the trochlea is a rough, blunt process, the *external condyle*, and from the inner part of the trochlea there is a more prominent process, the *internal condyle*, which occupies a lower plane than the external. The extensor muscles of the wrist and hand are attached to the external condyle, and the flexor muscles to the internal condyle.

The elbow is formed by the lower end of the humerus and the upper end of the ulna, which are so adapted to each other that they establish a hinge-joint (page 22) of very considerable strength by which the arm is connected with the forearm (Plate 8, Figs. 1, 2, 3, 4, 5 and 6).

There are two long bones in the *forearm, the ulna* and *the radius* (Plate 47, Figs. 1, 2 and 3, and Plate 48, Fig. 1). The upper end of the ulna is one of the most remarkable features of the skeleton. It consists of two conspicuous processes separated by a deep hollow, the *sigmoid cavity.* The process which extends backward is the *olecranon process,* and forms the prominence of the elbow. It is thick and strong, and ends in a curved tip, which is received into the olecranon fossa of the humerus when the forearm is extended. The back part of the olecranon is roughened for the attachment of the triceps extensor muscle (page 77). The sigmoid cavity is the part which articulates with the trochlea surface on the humerus. The cavity terminates in front in the *coronoid process,* which rests in the coronoid fossa of the humerus when the forearm is flexed. The base of the coronoid process is directly continuous with the shaft of the ulna. The *upper end of the radius,* although it is present within the elbow joint, does not properly take part in the function of that joint. The upper end of the radius is called its *head.* It is rounded and presents a cupped depression which glides upon the outer condyloid surface of the humerus. Below the head the radius is constricted, forming the *neck,* which has a ring-like ligament, the *orbicular* (Plate 8, Fig. 6), to connect it with the adjacent portion of the ulna. Where the neck joins the shaft there is, at the inner side of the bone, the prominent *bicipital tubercle,* at the posterior and under surface of which the tendon of the biceps flexor muscle is attached (Plate 43, Fig. 1).

The shafts of the ulna and radius (Plate 39), beyond their upper extremities, extend side by side to the wrist, and are peculiarly formed, not only to support the soft structures of the forearm, but also to be adapted to their respective functions; the ulna being employed principally in extension and flexion, while the office of the radius is to rotate the hand in pronation and supination. The radius is external on the thumb side, and the ulna is internal on the side of the little finger. The shaft of the ulna gradually diminishes in size from the upper end to the lower. It is prismatic in form and twisted on its axis, so that below the elbow it inclines a little toward the radius, becomes quite straight at its middle, and arches slightly away from the radius lower down, where its rounded surface bends back again to be received upon a depression on the adjacent border on the lower end of the radius. The

upper three-fourths of the radial or external border of the ulna is provided with a sharp edge; the internal border is smooth above and rough below. The *lower end of the ulna* is very small, and terminates in a blunt, pointed projection, the *styloid process*, resembling the end of an elephant's trunk. The *shaft of the radius* below the bicipital tubercle is prismatic in form and gradually increases in breadth to the lower fourth of the bone, where it is expanded into a large quadrilateral-shaped extremity, for articulation with the wrist. The shaft is slightly bent forward and inward, having a convex outer border and an inner or ulna border which presents a sharp edge similar to that on the ulna. These opposing edges of the radius and ulna are connected by the interosseous membrane which extends from one to the other.

The interosseous membrane strengthens the two bones and enables the hand to support a weight, or push against an object in extension, as when the humerus and ulna are in direct line, constituting the *humero-ulnar shaft*. The interosseous membrane limits the movement of the radius about the ulna; it also offers a broad surface for the attachment of the deep flexor and extensor muscles. The *lower end of the radius* is the broadest part of the bone. It presents two articular surfaces, the outer of which is triangular and the inner is quadrate, for the reception of the scaphoid and the semi-lunar bones of the wrist. The outer border terminates in the styloid process (Plate 39).

The skeleton of the hand (Plates 49 and 51) consists of the *wrist* or *carpus*, the median portion of the hand or *meta-carpus*, and the *phalanges*, or bones of the fingers. There are eight carpal bones, which are small and thick, and arranged in two rows of four each (Plate 51). In the upper row, counting from the external or radial side, are the scaphoid, semi-lunar, cuneiform and pisiform. In the lower row are the trapezium, trapezoid, magnum and unciform. When the bones of the wrist are collectively united they form an arch with its concavity toward the palm; the scaphoid and trapezium, the two outer bones of the two rows, and the pisiform and unciform, the two inner bones of the two rows, projecting laterally. The contiguous surfaces of the carpal bones are so adapted that they form with one another gliding joints, the motion between any two of them being very

slight, and limited to extension and flexion. The articulation between the two rows has, however, considerable motion and contributes to the flexion and extension of the hand.

The wrist joint (Plate 9, Figs. 5 and 6) consists of the articular surfaces of the lower end of the radius and the upper portions of the scaphoid and semi-lunar bones. The lower end of the ulna is separated from the wrist by a small triangular fibro cartilage.

There are five *meta-carpal bones* (Plate 51). They are modified long bones, each consisting of a somewhat triangular shaft, slightly bowed with the concavity toward the palm. The meta-carpal bone of the thumb is shorter and broader than the others, and its palmar surface is turned toward the ulna side of the hand. The joint between the trapezium and the meta-carpal bone of the thumb is distinct and protected by strong ligaments. The meta-carpal bone of the index finger is the longest, the rest of the series being shorter toward the little finger. All the meta-carpal bones diverge from the carpus.

The phalanges (Plates 49 and 51) are small, long bones, three in each finger and two in the thumb. They successively increase in size toward the wrist. The second phalanges of the middle and ring fingers are equal in length; that of the index finger is shorter and that of the little finger is the smallest of the series. The terminal phalanges have horse-shoe shaped *ungual processes*, which are roughened on the palmar surfaces. That of the thumb is the largest and broadest, while the corresponding processes of the middle, ring, index and little fingers follow in order as named.

The shoulder-joint (page 21) consists of the adaptation of the head of the humerus upon the glenoid fossa of the scapula (Plate 7). This joint is materially strengthened by the disposition of the tendons which pass over the capsule of the joint to be attached to the tuberosities of the humerus. The tendons are furnished by the biceps (page 76), supra-spinatus, infra-spinatus, teres minor and the sub-scapular muscles.

The supra-spinatus muscle (Plate 41, Fig. 1) is lodged in the supra-spinous fossa of the scapula. Its fibres arise from the inner portion of the bone and

converge into a strong tendon, which is inserted on the greater tuberosity of the humerus.

The infra-spinatus muscle (Plate 41, Fig. 1) arises from the ridge on the scapula below the spinous process, and its tendon is inserted on the greater tuberosity of the humerus.

The teres minor (lesser-round) muscle (Plate 41, Fig. 1) arises from the upper portion of the axillary border of the scapula and passes obliquely upward to be inserted also on the greater tuberosity of the humerus.

The tendons of these muscles strengthen the shoulder at its upper and back parts.

The teres major (greater round) muscle (Plate 41, Fig. 1) arises from the lower part of the axillary border and inferior angle of the scapula and ascends outwardly, diverging from the teres minor, so that its tendon blends with that of the latissimus dorsi muscle (page 64) and is inserted into the thoracic border of the bicipital groove of the humerus, thus forming the posterior border of the axilla or arm-pit.

The actions of the supra-spinatus, infra-spinatus and teres minor muscles serve to rotate the arm bone outwardly. When the arm is raised by the deltoid muscle they assist in retaining it in that position.

The action of the teres major muscle.—This muscle assists the latissimus dorsi (page 64) in drawing the arm downward and inward.

The tendons of the above muscles are covered by the *great deltoid muscle*, which forms a complete shoulder-cap (Plate 41, Figs. 2, 3 and 4).

The *deltoid muscle* was so called because of its resembling the Greek letter △ reversed. It arises from the lower border of the outer portion of the clavicle, the acromion process, and nearly the whole of the spine of the scapula. This extensive origin corresponds to that of the trapezius muscle above (page 64). The fibres of the deltoid are very coarse and arranged in bundles which are separated by inward expansions of the strong sheath of the muscle derived from the deep fascia. The bundles arising from the clavicle and the spine of the scapula generally converge to their insertion at the sides of the deltoid tuberosity at the middle of the outer side of the shaft of the humerus, while those from the acromion process are peculiarly arranged. There are additional fibres arising from the septa within the muscle

itself which pass vertically to be attached to a median ridge on the deltoid tuberosity. In this way the bundles reinforce one another, and the increased number of their fibres compensates for their length, thus greatly augmenting the functional power of the whole muscle. From the front the attachment of the deltoid muscle resembles the letter V (Plates 40 and 41); it is embraced by the two origins of the brachialis anticus, and this occasions the characteristic depression of the overlying skin.

Action of the deltoid muscle.—The three portions of the deltoid can act independently (Plates 41, 42 and 102) in raising the arm forward, outward or backward, each acting to better advantage when the humerus is rotated outwardly by the supra-spinatus, infra-spinatus, and teres minor muscles. The power of the deltoid depends greatly upon the scapula being steadied by its controlling muscles. When the whole muscle contracts it raises the arm to the horizontal position at a right angle with the trunk. Beyond this it cannot act, further elevation being effected by the serratus magnus and trapezius muscles, which then raise the shoulder.

The axilla, or arm-pit, varies in depth with the position of the arm (Plates 22 and 42). It is a pyramidal space, bounded internally by the side of the thorax, externally by the arm, and in front and behind by prominent muscular folds. The anterior fold is formed by the lower border of the pectoralis major muscle (page 54), while the posterior fold is formed by the lower borders of the latissimus dorsi and teres major muscles (page 64). The inner wall of the axilla is formed by the four upper ribs, with the intercostal muscles, covered by the serratus magnus muscle (Plate 28). The skin of the axilla is closely connected with the superficial fascia of this region, and is provided with long hairs radiating toward the borders of the cavity.

The muscles of the arm (Plates 40, 43 and 44) are the biceps, the coraco-brachialis, the brachialis anticus, and the triceps.

The *biceps muscle* (Plate 43, Fig. 1) is so called because it has a double origin. The *long head* arises by a long, round tendon from the top of the glenoid fossa of the scapula, which arches over the head of the humerus

within the capsule of the shoulder joint, pierces the latter between the two tuberosities, and descends in the *bicipital groove* between them. It is held in place by the tendon of the pectoralis major muscle, which passes over to be inserted into the outer border of the groove. Owing to this disposition of the long tendon it serves as a ligament, greatly strengthening the front of the shoulder joint. The *short head* arises from the point of the coracoid process of the scapula. The fibres from the two heads unite about the middle of the front of the arm and form a single mass which is subject to great variations in development in different individuals. It terminates suddenly in a flat tendon, which is inserted into the lower and back part of the bicipital tubercle of the radius. This muscle is of considerable length, and being subcutaneous, can be readily felt upon its contraction. From the tendon a leaflet is given off which blends with the deep fascia covering the flexor muscles of the forearm. This disposition of the insertion of the biceps tendon augments the power of flexion of the forearm in contending with resistance, as in pulling the body forward or lifting a weight.

Action of the biceps muscle.—Its action is to both flex and supinate the forearm when the elbow is bent.

The coraco-brachialis muscle (Plate 28, Fig. 1) arises from the coracoid process of the scapula in common with the short head of the biceps, and is inserted at the middle of the inner side of the shaft of the humerus opposite the insertion of the deltoid.

Action of the coraco-brachialis muscle.—Its action is to draw the arm upward and inward toward the side of the chest. It is the hugging muscle, which is peculiarly developed in the bear tribe.

The brachialis anticus muscle (Plate 43, Fig. 2) arises by two portions which embrace the insertion of the deltoid and from the front surface of the humerus, and passes over the front of the elbow joint to be inserted on the coronoid process of the ulna.

Action of the brachialis anticus muscle.—It serves to flex the elbow.

The triceps muscle (Plate 44, Fig. 1) has three origins, as its name indicates. It is situated at the back of the arm. The middle head is the longest and arises from the bottom of the glenoid fossa of the scapula. The

outer head arises from the upper end of the humerus below the external tuberosity. The inner head arises from the back part of the upper end of the humerus. The three portions unite about the middle of the back of the arm, and the resulting tendon is very thick and strong. It is inserted into the top and sides of the olecranon process of the ulna.

Action of the triceps muscle.—It acts as a powerful extensor of the forearm upon the upper arm.

The condyles are the only parts of the humerus which are sub-cutaneous, and although the shaft can be felt through the soft structures there are no other bony prominences; therefore, *the surface marking,* which is due to the contour of the muscles, is of particular interest. This is more pronounced in muscular men than in women, whose arms are rounded and of regular outline. Fat, here as in other parts of the body, always subdues the depressions and renders them less noticeable.

The *skin over the region of the shoulder* is comparatively thin, and, although there may be a considerable amount of fat in the sub-cutaneous tissue in certain localities, which softens and subdues the surface markings, yet the prominences of the bony framework can always be felt through the skin. These landmarks are of exceeding value to the artist, and in order to determine them with accuracy it is advisable to compare the corresponding points of both shoulders.

The skin in the front and inner side of the arm is very smooth and delicate. The deltoid depression is usually easily recognizable, and the bulge of the biceps muscle causes its outline to be usually well defined, so that there are furrows or depressions on each side of it.

The skin over the elbow is very thin and fine, so that the relations of the tendon of the biceps muscle can be easily recognized; whereas behind, over the olecranon, the skin is loose and has a roughened cuticle which is puckered into transverse wrinkles when the forearm is extended.

At the bend of the elbow the superficial veins can usually be distinguished through the integument if there is not much fat. They often present an M-shaped appearance.

In consequence of the obliquity of the trochlear surface of the lower end of the humerus when the elbow is extended and the hand supinated, the forearm diverges from the line of the arm at an angle of about ten degrees. (Plate 39.) A line drawn through the condyles will form a right angle with the axis of the arm, but an obtuse angle with the axis of the forearm. This explains why in flexion the forearm inclines inward so that the hand is brought to the middle line of the body, and also why it is not possible for the hand to be placed flat upon the shoulder of the same side.

The muscles of the forearm are arranged in two groups—an anterior group consisting of the flexors and pronators, and a posterior group consisting of the extensors and supinators. Each group further consists of two layers, superficial and deep.

The *superficial layer* of the anterior group of muscles of the forearm comprises five muscles which, from within outward, are the pronator radii teres, the flexor carpi radialis, the palmaris longus, the flexor sublimis digitorum, and the flexor carpi ulnaris.

The pronator radii teres muscle (the round pronator of the radius) (Plate 45, Fig. 1) arises by two portions, one from the internal condyle, and another from the coronoid process of the ulna. The fibres pass obliquely to be inserted on the outer side of the upper part of the radius.

Action of the pronator radii teres muscle.—It serves to rotate the radius on the ulna (Plates 47 and 48), acting in conjunction with the pronator quadratus.

The flexor carpi radialis muscle (the radial flexor of the wrist) (Plate 45, Fig. 2) arises from the internal condyle, and its fibres terminate about the middle of the forearm in a long tendon, which is inserted into the base of the meta-carpal bone of the index finger.

Action of the flexor carpi radialis muscle.—Its function is to flex the wrist and adduct the hand, or, acting from below, it may assist in flexing the elbow.

The palmaris longus muscle (the long flexor of the palm) (Plate 50, Figs. 1 and 2) is occasionally absent. When present its fleshy part is always small

and has a long, slender tendon, which descends along the middle of the forearm to the wrist, where it blends with the fascia of the palm of the hand (Plate 50, Fig. 2).

The flexor carpi ulnaris muscle (the ulna flexor of the wrist) (Plate 45, Fig. 3) arises from the internal condyle and the olecranon, and from the upper two-thirds of the ulna and its tendon is attached to the pisiform bone.

Action of the flexor carpi ulnaris muscle.—Its function is to flex and adduct the wrist.

The flexor sublimis digitorum muscle (the superficial flexor of the fingers), (Plate 46, Fig. 1) lies under the other superficial muscles. It arises from the internal condyle of the humerus from the inner side of the coronoid process and adjacent upper part of the radius, and its fibres combine into one fleshy mass, from which are given off four tendons arranged in two superposed pairs. The superficial pair of tendons are continued to the middle and ring fingers, while the deeper pair go to the index and little fingers. Each of the tendons, in relation to the meta-carpal phalangeal joint (knuckle joint) of its special finger, divides into two lateral slips (Plate 46, Fig. 1), which diverge at the middle of the first phalanx, so as to allow the corresponding tendon of the flexor profundus muscle (deep flexor) to pass between them. The lateral slips of the superficial tendons are inserted at the sides of the second phalanges.

Action of the flexor sublimus muscle.—Its function is to flex the second joints of the fingers.

The deep layer of the anterior group of muscles of the forearm are the flexor profundus, the flexor longus pollicis and the pronator quadratus.

The flexor profundus digitorum muscle (deep flexor of the fingers) (Plate 46, Fig. 2) arises from the anterior surface of the ulna and from the interosseous membrane, and is arranged in two fleshy portions, the outer of which passes directly to the index finger, being inserted at the base of the ungual phalanx. The inner portion divid s into three flat tendons which are respectively inserted at the bases of the ungual phalanges of the three other fingers. At the middle of the first phalanges the deep tendons perforate the superficial tendons as above described.

Action of the flexor profundus muscle.—Its function is to flex the finger tips. (Plate 50.)

The flexor longus pollicis muscle (the long flexor of the thumb) (Plate 45, Fig. 4) arises from the upper part of the shaft of the radius and the adjacent part of the interosseous membrane, and its tendon is inserted into the base of the ungual phalanx of the thumb.

Action of the flexor longus pollicis muscle.—Its action is to strongly flex the thumb.

The pronator quadratus muscle (the square pronator) (Plate 45, Fig. 1) is a square-shaped muscle arising from the lower fourth of the ulna, and passing to be inserted upon the lower fourth of the radius on its anterior surface and outer border.

Action of the pronator quadratus muscle.—Its function is to pronate the radius in conjunction with the pronator teres muscle.

There are seven muscles of the superficial layer of the posterior group of the forearm which are arranged from the radial to the ulnar border in the following order: The supinator radii longus, the extensor carpi radialis longior, the extensor carpi radialis brevior, the extensor communis digitorum, the extensor minimi digiti, the extensor carpi ulnaris, and the anconeus.

The supinator radii longus muscle (the long supinator of the radius) (Plate 45, Fig. 2) is the most external of the muscles of the radial side of the forearm. It arises from the external condyle and terminates about the middle of the forearm in a flat tendon which is inserted at the outer side of the base of the styloid process of the radius.

Action of the supinator longus muscle.—It acts as a supinator upon the wrist, but also aids the anterior muscles in flexing the forearm.

The extensor carpi radialis longior muscle (the longer radial extensor of the wrist) (Plate 46) arises from the external condyle, and its tendon is inserted on the meta-carpal bone of the index finger at its outer and upper side.

The extensor carpi radialis brevior muscle (the shorter radial extensor of the wrist) (Plate 46, Fig. 3) arises with the preceding muscle from the external

condyle, and its tendon is inserted at the radial side of the base of the meta-carpal bone of the middle finger.

Action of the extensor longior and brevior muscles.—The function of the above two muscles is to extend the wrist.

The extensor communis digitorum muscle (the common extensor of the fingers) (Plate 44, Fig. 2) arises from the external condyle, and divides on the back of the forearm into three portions which are distributed by four tendons (two from the inner portion) to the fingers. At the back of the hand the tendons of the extensor communis diverge from one another at the knuckle joints (Plate 49, Fig. 1) where they give off lateral expansions to the sides of those joints. The two middle tendons generally pass over the two middle meta-carpal bones, while the tendons of the index finger pass obliquely across the space between the first and second meta-carpal bones, and the tendons of the little finger continue in close relation to that of the ring finger as far as the meta-carpal phalangeal joint, where it diverges abruptly to pass to its insertion. These tendons are often connected by accessory slips (vincula) above the knuckle joints. They are subject to great variety. The tendon of the index finger is usually free. On the back of each finger, after giving off the lateral slips at the knuckle joints, the tendons extend along the fingers to the ungual phalanges.

Action of the extensor communis digitorum muscle.—Not only is the function of this muscle to act as a general extensor of the fingers, but it can also act so as to extend the first phalanges while the second and third are flexed, and to extend the second and third phalanges while the first is flexed.

The extensor minimi digiti muscle (the extensor of the little finger) (Plate 49, Fig. 1) arises from the external condyle, and is a long slender muscle, the tendon of which passes in close relation with the tendons of the common extensor, and on the back of the hand it divides into two slips which pass to the little finger.

Action of the extensor minimi digiti muscle.—Its special function is to extend the little finger independently.

The extensor carpi ulnaris muscle (the ulnar extensor of the wrist) (Plate 46, Fig. 3) arises from the external condyle and from the posterior

border of the ulna and its tendon, which is strong and broad, is inserted into the under side of the base of the meta-carpal bone of the little finger.

Action of the extensor ulnaris muscle.—Its function is to extend the hand toward the ulnar side.

The anconeus muscle (the elbow muscle) (Plate 46, Fig. 4) is at the back of the elbow and is practically a continuation of the triceps muscle of the arm. It arises from the back of the external condyle and the capsule of the elbow joint and is inserted into the upper fourth of the ulna, which it assists in extending.

The muscles of the deep layer of the posterior group of the forearm are the supinator radii brevis, the three extensor muscles of the thumb, and the extensor indicis.

The supinator radii brevis muscles (the short radial supinator) (Plate 46, Fig. 4) arises beneath the other extensor muscles at the external condyle and the orbicular ligament at the neck of the radius (page 72) and from the adjacent portion of the ulna. Its tendon is inserted into the radius between the bicipital tubercle and the attachment of the pronator teres muscle. It is a supinator of the radius.

The three extensor muscles of the thumb (Plate 46, Fig. 4) arise from the upper parts of the shafts of the radius and ulna, and from the interosseous membrane, and are inserted respectively into the base of the meta-carpal bone of the thumb at its joint with the trapezium, the base of the first phalanx of the thumb and the base of the ungual phalanx.. The tendons are of great interest, as the thumb is the chief feature of the expression of the hand. The tendon inserted at the base of the first phalanx is peculiar to the human hand.

Action of the extensor muscles of the thumb.—These muscles severally extend the portion of the thumb to which they are attached. They can be readily distinguished through the skin.

The extensor indicis muscle (the extensor of the index finger) (Plate 46, Fig. 4) arises from the back of the ulna and the interosseous membrane, and is inserted with the tendon of the common extensor at the metacarpo-phalangeal joint of the index finger.

Action of the extensor indicis muscle.—It enables the index finger to be extended independently, and is used in pointing. (Plate 50, Fig. 4.)

The spaces between the meta-carpal bones are occupied by the *interosseous muscles of the hand* (Plate 49, Figs. 1 and 3), which are arranged in two sets, palmar and dorsal. There are three *palmar interosseous muscles.* The first arises from the base and front of the meta-carpal bone of the index finger and is inserted into the ulnar side of the three phalanges belonging to that finger. The second arises from the meta-carpal bone of the ring finger and is inserted into the radial side of its phalanges. The third arises from the meta-carpal bone of the little finger and is inserted into the radial side of its phalanges. There are four *dorsal interosseous muscles.* The first arises from the ulnar side of the meta-carpal bone of the thumb and the adjacent side of the meta-carpal bone of the index finger and is inserted into the radial side of its phalanges. The second arises from the adjacent side of the meta-carpal bones of the index and middle fingers and is inserted into the radial side of the phalanges of the middle finger. The third arises from the adjacent sides of the meta-carpal bones of the middle and ring fingers, and is inserted into the ulnar side of the phalanges of the middle finger. The fourth arises from the adjacent sides of the meta-carpal bones of the ring and little fingers and is inserted into the ulnar side of the phalanges of the ring finger.

Action of the interosseous muscles.—The general function of the palmar set is to adduct the fingers toward the middle line of the middle finger; while that of the dorsal set is to abduct the fingers from that line. It should be understood that each finger is provided with an *aponeurotic sheath,* beginning at the knuckle joints, where the common extensor tendons split into lateral expansions, and extending over the entire skeleton of each finger. It is into this sheath that the tendons of the interossii muscles are inserted, rather than into the bones, at the several points above indicated.

Besides the interosseous muscles there are four other small muscles called the *lumbricales,* resembling earth-worms. They arise from the deep flexor tendons in the palm of the hand (Plate 49, Fig. 3), and are inserted into the sheaths of each of the fingers on their radial side.

Action.—Their function is to flex the knuckle joints, but they can assist the action of the extensor tendons in maintaining the extension of the joints between the phalanges. It should be noted that the meta-carpal-phalangeal joints are capable of being flexed so that the fingers may be brought into the hollow of the palm, thus forming the fist, while the prominences of the bones at the joints are the *knuckles*. Of these the knuckle of the middle finger is always the most prominent, and, as it is a distinguishing feature of the hand, it should be especially noted, as it is a landmark. Its proper representation by the artist gives character and expression to the individual hand. The fingers can be extended only very little beyond the plane of the metacarpus, but they can be readily moved laterally.

The joint of the thumb, between the meta-carpal bone and the trapezium, enables it to be opposed to all the fingers. Besides the special flexor (page 80) and extensor (page 83) muscles of the thumb, there are others which constitute *the ball of the thumb*.

The abductor pollicis muscle (abductor of the thumb) (Plate 48, Fig. 3) arises from the trapezium and is inserted into the outer side of the first phalanx of the thumb.

Action of the abductor pollicis muscle.—Its action draws the thumb away from the rest of the hand.

The *opponens pollicis muscle* (opposing muscle of the thumb) (Plate 48, Fig. 2) arises beneath the abductor, also from the trapezium, and is inserted into the radial border of the meta-carpal bone of the thumb.

Action of the opponens pollicis muscle.—Its action is to bring the thumb forcibly in opposition with all the fingers.

The *flexor brevis pollicis* (short flexor of the thumb) (Plate 48, Fig. 2) arises by two portions, one from the trapezium, and the other from the meta-carpal bones of the index and middle fingers. They are inserted into the first phalanx of the thumb.

Action of the flexor brevis pollicis muscle.—It flexes the thumb upon the palm.

The adductor pollicis muscle (adductor of the thumb) (Plate 48, Fig. 3) is triangular and arises from the meta-carpal bone of the middle finger. It is inserted into the first phalanx of the thumb, with the preceding muscle.

Action of the adductor pollicis muscle.—It aids by its action the flexor brevis muscle. It further enables the tip of the thumb to be brought into contact with the tips of the fingers. The mobility of the thumb, and the power which it possesses through its many muscles, renders it one of the distinguishing features of the human hand.

The *muscles of the ball of the little finger* (Plate 48, Figs. 2 and 3) resemble somewhat those of the thumb.

The *abductor minimi digiti muscle* (abductor of the little finger) (Plate 48, Fig. 2) arises from the pisiform bone, and is inserted into the ulnar side of the first phalanx of the little finger.

The *flexor brevis minimi digiti muscle* (short flexor of the little finger) (Plate 48, Fig. 3) is really a part of the above.

Action of the flexor brevis minimi digiti muscle.—It acts in drawing the little finger away from the rest of the hand.

The *opponens minimi digiti muscle* (opposing muscle of the little finger) (Plate 48, Fig. 3) arises beneath the flexor brevis from the unciform bone, and is inserted on the ulnar side of the meta-carpal bone of the little finger.

Action of the opponens minimi digiti muscle.—It draws the little finger upon the palm so as to strengthen the power of grasping.

The surface markings of the wrist and hand are of considerable importance. The position of all the prominences of the skeleton of this region should be noticed in extension and flexion, as well as in supination and pronation (Plate 47). The lower ends of the radius and ulna can be readily defined because they are to a great extent superficial. The styloid process of the radius is about half an inch lower than the styloid process of the ulna, and when the shafts of the bones are parallel, projects a little more forward.

The annular ligaments at the wrist (Plate 49, Figs. 1 and 3) are condensations of the deep fascia which confine the tendons of the various muscles which pass from the forearm to the hand. The anterior is the strongest and one of the most unyielding fibrous structures in the body. Each tendon has a

separate compartment as it passes through the annular ligaments, and is lubricated by a synovial bursa to obviate friction.

The skin over the wrist is quite loose, thin, and free from fat. In front of the wrist the skin is closely connected with the deep fascia, and is marked by *transverse lines*, of which the lowest is usually very distinct, and is about three-quarters of an inch below the wrist joint (Plates 52 and 53). These lines are caused by the flexion of the wrist joint.

The skin over the back of the hand is very fine, and loosely attached to the deep fascia. The superficial veins over the back of the hand should be noted by the artist, especially in the case of the hands of old people. There is much diversity in the arrangement of these veins, and they are always more distended when the hands are in a pendant position.

The palm of the hand presents a large prominence on the radial side formed by the muscles of the ball of the thumb, and upon the ulnar side a long prominence corresponding to the muscles of the ball of the little finger. The two prominences are sometimes called *the heel of the hand.* Between them there is a depression which broadens toward the fingers, and when the latter are flexed, forms *the hollow of the hand.* The skin of the palm is attached to the deep fascia along the many *lines of flexion*, three of which are especially noteworthy. The first line curving around the base of the ball of the thumb is caused by the constant flexion of the thumb (*linea vitalis*, line of life) (Plate 52, Fig. 1). The second line extends across the palm from the knuckle joint of the index finger to about the middle of the meta-carpal bone of the little finger, and is caused by the apposition of the thumb with the index and middle fingers (*linea cephalica*, line of the head) (Plate 52, Fig. 1). The third line commences at the space opposite the knuckle joints of the index and middle fingers, and extends obliquely to the ulnar border of the hand. It is caused by the flexion of the middle, ring and little fingers (*linea mensalis*, line of the mind), (Plate 52, Fig. 1). There is also another line, less conspicuous, which takes a vertical course over the meta-carpal bone of the middle finger (*linea hepatica*, line of the liver), (Plate 52, Fig. 1). When all these lines are distinct they present the form of the letter *M.* The palmar surface at the bases of the fingers is marked by transverse flexion folds which are single for the

index and little fingers, and double for the middle and ring fingers. There are similar folds produced by the flexion of the joints between the phalanges, the first of which is double and the second usually single for each finger (Plate 52, Fig. 1). The thumb is provided with two folds corresponding to its two joints.

The cuticle of the palms of the hands varies in thickness mainly according to the uses to which the hands are put.

The nails are horny plates surmounting the finger tips upon their dorsal surfaces. The part of each nail where it is protected by the skin is very thin, and appears white and opaque, and owing to its crescent shape it is called the *lunula* (Plate 52, Figs. 2, 3, 4, 5, and Plate 53). The latter is always more pronounced in the thumb than in the fingers. The nails vary in different individuals.

The general form of the hand depends upon the skeleton, but especially is this noticeable on the back or dorsal surface; the palmar surface of the bones being covered by the tendons and interosseous muscles so that they are concealed. On the back of the hand there are only the extensor tendons going to the backs of the fingers, and these should be closely observed as in the various actions of the fingers they come more or less into relief and contribute much to the character of the individual hand. There is usually more fat on the backs of the hands of women and children than of men, which masks the outlines of the tendons.

PLATE 38.

Fig. 1. The right scapula (*front*).

1. The acromion process.
2. The coracoid process.
3. The glenoid fossa.
4. The neck.
5. The venter.
6. The axilary border.
7. The inferior angle.
8. The notch.
9. The superior angle.
10. The vertebral border.

Fig. 2. The right scapula (*side*).

1. The acromion process.
2. The glenoid fossa.
3. The dorsum.
4. The coracoid process.

Fig. 3. The right scapula (*back*).

1. The superior angle.
2. The supra-spinous fossa.
3. The spinous process.
4. The infra-spinous process.
5. The acromion process.
6. The glenoid fossa.
7. The dorsum.

Fig. 4. The right clavicle (*front*).

1. The Acromial end.
2. The sternal end.

Fig. 5. The right clavicle (*from above*).

1. The acromial end.
2. The sternal end.

Fig. 6. The right humerus (*front*).

1. The external tuberosity.
2. The bicipital groove.
3. The cylindrical portion of the shaft.
4. The prismoid portion of the shaft.
5. The depression for the coronoid process of the ulna.
6. The external condyle.
7. The trochlear surface.
8. The trochlear eminence.
9. The head.

Fig. 6—continued.

10. The neck.
11. The anterior tuberosity.
12. The internal condyle.

Fig. 7. The right humerus (*back*).

1. The head.
2. The neck.
3. The cylindrical portion of the shaft.
4. The prismoid portion of the shaft.
5. The internal condyle.
6. The trochlear eminence.
7. The trochlear surface.
8. The external tuberosity.
9. The depression for the olecranon process of the ulna.
10. The external condyle.

Fig. 8. The right humerus (*outer side*).

1. The head.
2. The external tuberosity.
3. The prismoid portion of the shaft.
4. The external condyle.
5. The neck.
6. The trochlear surface.

Fig. 9. The right humerus (*inner side*).

1. The head.
2. The anterior tuberosity.
3. The trochlear.
4. The neck.
5. The prismoid portion of the shaft.
6. The internal condyle.

Fig. 10. The sternum (*front*).

1. The notch for the right clavicle.
2. The notch for the cartilage of the first rib.
3. The manubrium.
4. The joint between the manubrium and the gladiolus.
5. The gladiolus.
6. The enciform cartilage.
7. The notch for the left clavicle.
8. The notch for the cartilage of the first rib.
9. The notch for the cartilage of the second rib.

(*Continued*)

PLATE 38

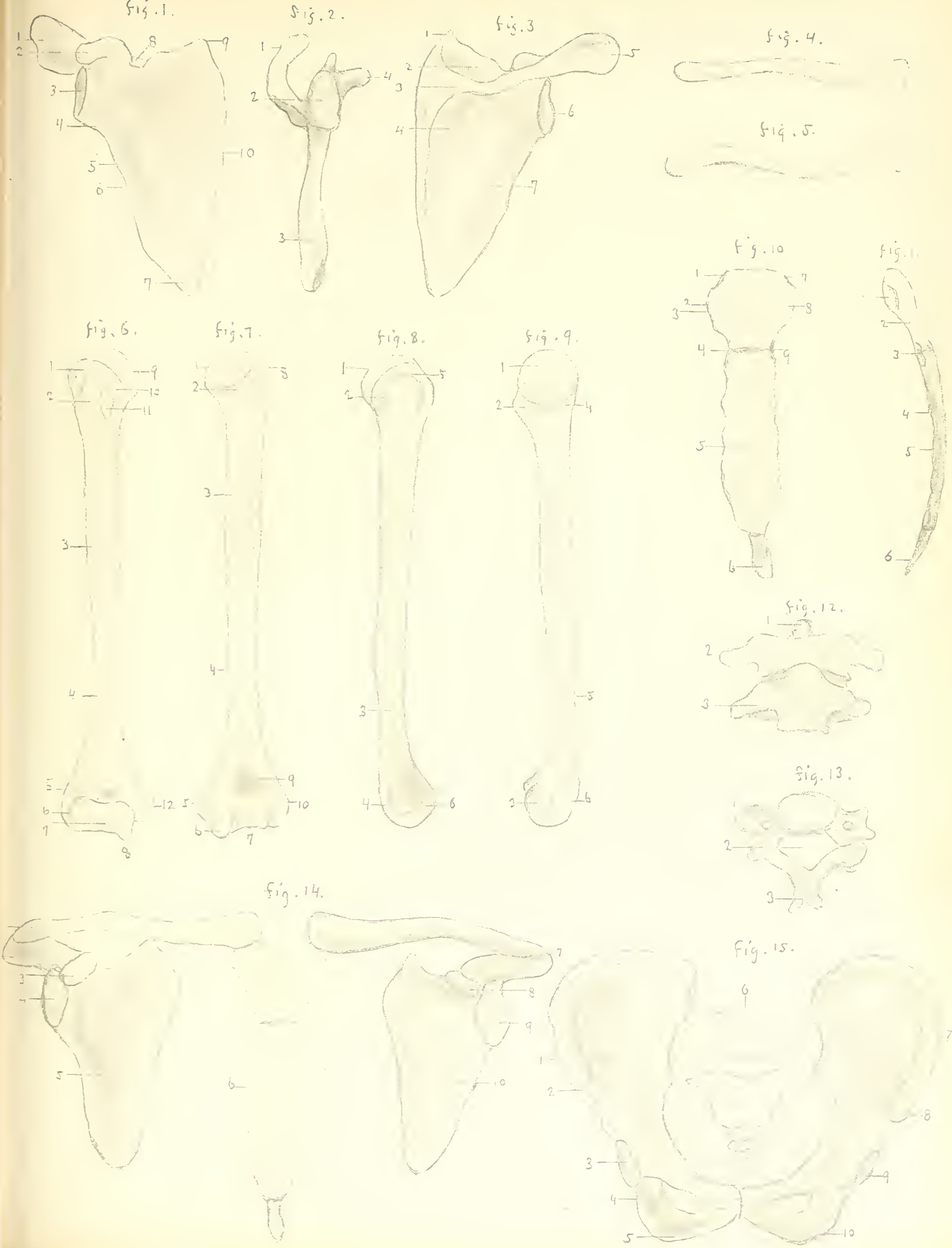
fig. 1.
fig. 2.
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fig. 6.
fig. 7.
fig. 8.
fig. 9.
fig. 10
fig. 12.
fig. 13.
fig. 14.
Fig. 15.

PLATE 38. (*Continued*)

Fig. 11. The sternum (*right side*).

1. The notch for the cartilage of the first rib.
2. The manubrium.
3. The notch for the cartilage of the second rib.
4. The notch for the cartilage of the third rib.
5. The notch for the cartilage of the fourth rib.
6. The enciform cartilage.

Fig. 12. The first and second cervical vertebra in apposition.

1. The odontoid process of the second cervical vertebra.
2. The first or Atlas vertebra.
3. The second cervical vertebra.

Fig. 13. The fifth cervical vertebra.

1. The body.
2. The foramen.
3. The bifid spine.

Fig. 14. The shoulder girdle.

1. The acromial end of the right clavicle.
2. The acromion process of the right scapula.
3. The coracoid process of the right scapula.
4. The glenoid fossa.
5. The venter of the scapula.
6. The gladiolus of the sternum.
7. The left shoulder.
8. The coracoid process of the lett scapula.
9. The glenoid fossa.
10. The venter of the left scapula.

Fig. 15. The pelvic girdle.

1. The right ilium.
2. The anterior spinous process of the ilium.
3. The acetabulum.
4. The symphisis pubis.
5. The right ischium.
6. The sacrum.
7. The left ilium.
8. The anterior spine of the ilium.
9. The acetabulum.
10. The left ischium.

N. B.—The above are drawings from photographs.

PLATE 39.

Fig. 1. The skeleton of the entire right upper extremity, with outline (*from the back*). Drawn from a photograph.

1. The superior angle of the scapula.
2. The vertebral border of the scapula.
3. The inferior angle of the scapula.
4. The shaft of the humerus.
5. The internal condyle of the humerus.
6. The olecranon process of tne ulna.
7. The shaft of the ulna.
8. The styloid process of the ulna.
9. The semi-lunar bone.
10. The cuneiform bone.
11. The metacarpal bone of the little finger.
12. The proximal phalanx of the little finger.
13. The intermediary phalanx of the little finger.
14. The ungual phalanx of the little finger.
15. The clavicle.
16. The acromion process of the scapula.
17. The head of the humerus.
18. The external condyle of the humerus.
19. The head of the radius.
20. The bicipital tubercle of the radius.
21. The shaft of the radius.
22. The styloid process of the radius.
23. The scaphoid bone.
24. The ungual phalanx of the thumb.

Fig. 2. The skeleton of the entire right upper extremity, with outline (*from the front*). Drawn from a photograph.

1. The clavicle.
2. The acromion process of the scapula.
3. The coracoid process of the scapula.
4. The external tuberosity of the humerus.
5. The anterior tuberosity of the humerus.
6. The shaft of the humerus.
7. The external condyle of the humerus.
8. The head of the radius.
9. The tubercle of the radius.
10. The shaft of the radius.
11. The styloid process of the radius.
12. The scaphoid bone.
13. The metacarpal bone of the thumb.
14. The metacarpal bone of the index finger.
15. The ungual phalanx of the thumb.
16. The proximal phalanx of the index finger.
17. The intermediary phalanx of the index finger.
18. The internal condyle of the humerus.
19. The upper end of the ulna.
20. The shaft of the ulna.
21. The styloid process of the ulna.
22. The semi-lunar bone.


Fig. 1.
Fig. 2.

PLATE 40.

Fig. 1. Diagram of the muscles of the right upper extremity *(from the back).*

1. The supra spinatis muscle.
2. The infra spinatis muscle.
3. The teres major muscle.
4. The teres minor muscle.
5. The triceps muscle.
6. The internal condyle of the humerus.
7. The extensor carpi ulnaris muscle.
8. The extensor minimi digiti muscle.
9. The tendons of the communis digitorum muscle.
10. The deltoid muscle.
11. The external condyle of the humerus.
12. The tendon of the triceps muscle.
13. The extensor communis digitorum muscle.
14. The tendons of the extensor muscles of the thumb.

Fig. 2. Diagram of the muscles of the right upper extremity *(from the front).*

1. The deltoid muscle.
2. The brachialis anticus muscle.
3. The biceps muscle.
4. The tendon of the biceps muscle.
5. The supinator longus muscle.
6. The tendon of the flexor longus pollicis muscle.
7. The pectoralis major muscle.
8. The brachialis anticus muscle.
9. The internal condyle of the humerus.
10. The flexor sublimis digitorum muscle.
11. The flexor carpi ulnaris muscle.
12. The tendons of the flexor sublimis digitorum muscle.

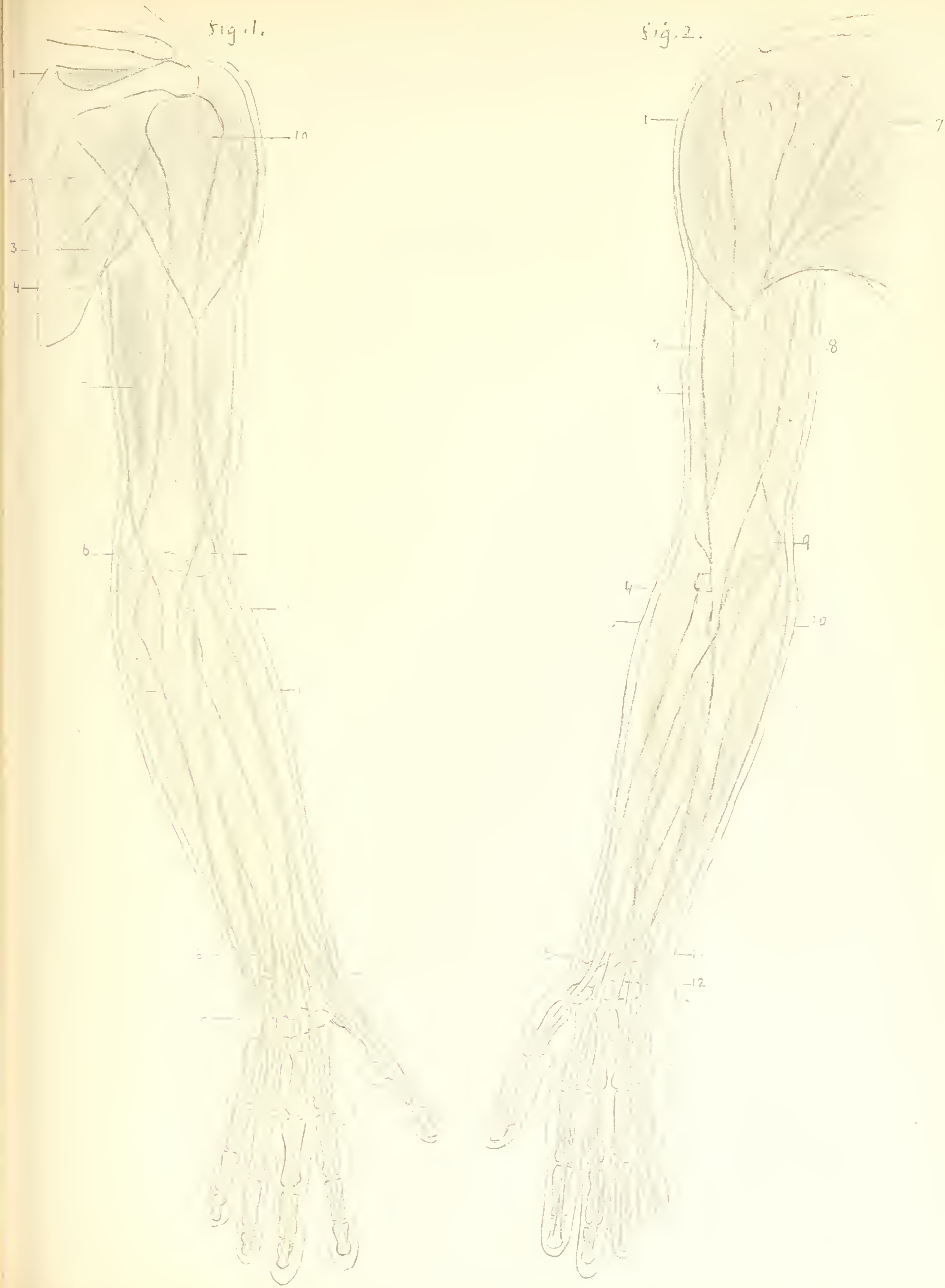
Fig. 1.
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PLATE 41.

Fig. 1. The muscles of the right scapula.

1. The first rib.
2. The clavicle.
3. The supra spinatus muscle.
4. The infra spinatus muscle.
5. The teres minor muscle.
6. The teres major muscle.
7. The eighth rib.
8. The ninth rib.

Fig. 2. The right deltoid muscle (*from the back*).

1. The posterior portion of the deltoid muscle.
2. The insertion of the deltoid muscle.

Fig. 3. The right deltoid muscle (*from the outer side*).

1. The first rib.
2. The second rib.
3. The inferior angle of the scapula.
4. The clavicle.
5. The acromion process of the scapula.
6. The deltoid muscle.
7. The insertion of the deltoid muscle.

Fig. 4. The right deltoid muscle (*from the front*).

1. The clavicle.
2. The position of the coracoid process of the scapula.
3. The front portion of the deltoid muscle.
4. The insertion of the deltoid muscle.
5. The seventh rib.

Fig. 1.

Fig. 2

Fig. 3

Fig. 4.

PLATE 42.

Fig. 1. Photograph of a man with the right arm extended holding a heavy dumb-bell, showing the surface markings (*from the front*).

Fig. 2. Photograph of a man in same position as Fig. 1, showing the surface markings (*from the back*).

Fig. 1

PLATE 42 B

Fig. 2

PLATE 43.

Fig. 1. Diagram of the skeleton of the trunk, with the right arm, showing the attachments of the biceps muscle, the quadratus lumborum, gluteus minimis and pyriformis muscles.

1. The first rib.
2. The coracoid process of the scapula.
3. The long or glenoid head of the biceps muscle.
4. The short or coracoid head of the biceps muscle.
5. The biceps muscle.
6. The twelfth rib.
7. The quadratus lumborum muscle.
8. The tendon of the biceps muscle.
9. The bicipital tubercle of the radius.
10. The gluteus minimis muscle.
11. The pyriformis muscle.

Fig. 2. Diagram showing the attachments of the brachialis anticus muscle and the ilio-psoas muscle.

1. The coracoid process of the scapula.
2. The bicipital groove of the humerus.
3. The origins of the brachialis anticus muscle.
4. The brachialis anticus muscle.
5. The psoas muscle.
6. The insertion of the brachialis anticus muscle.
7. The iliacus muscle.
8. The insertion of the ilio-psoas muscle.

Fig. 1.

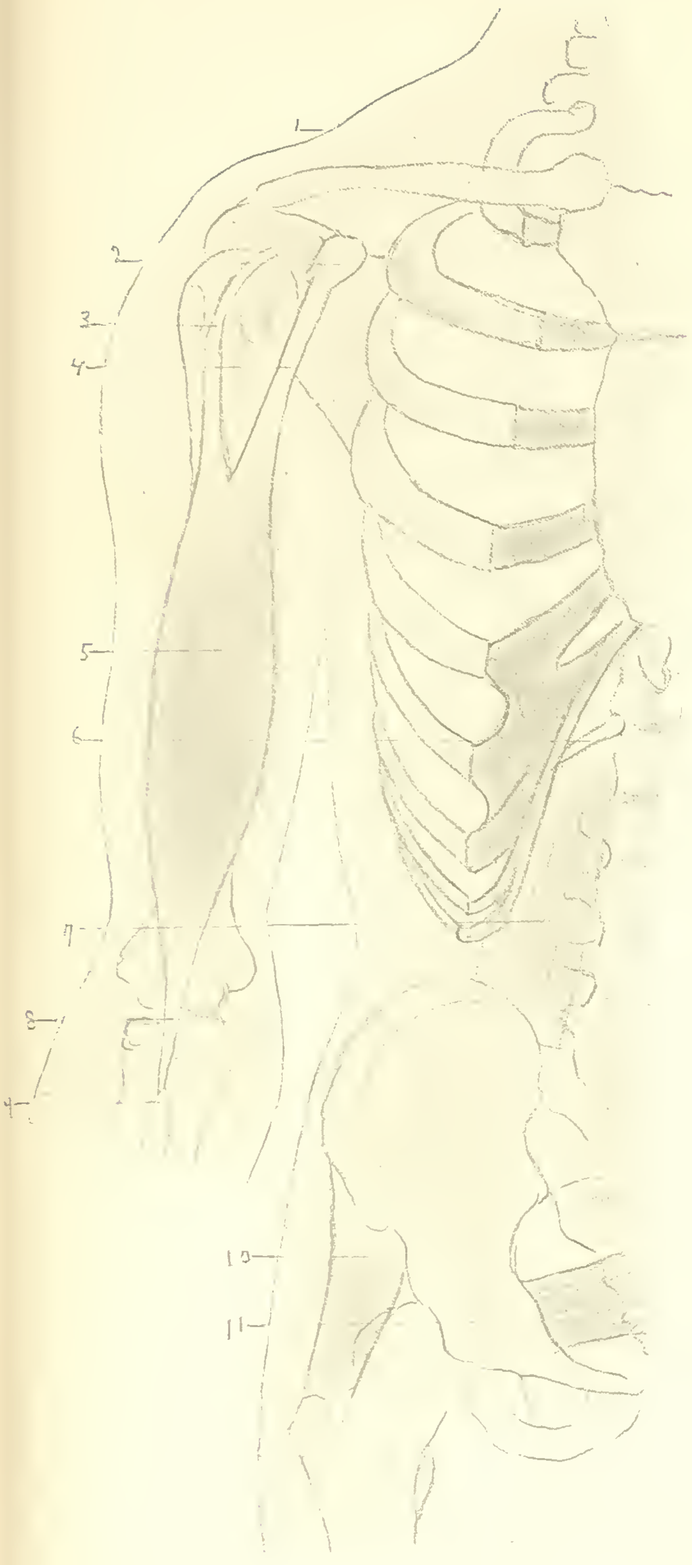

Fig. 2.

PLATE 44.

Fig. 1. Diagram of the right side of the trunk showing the attachments of the triceps muscle and the quadratus lumborum, the gluteus medius, the pyriformis, two gemelli and quadratus femoris muscles.

1. The outer head of the triceps muscle.
2. The middle head of the triceps muscle.
3. The inner head of the triceps muscle.
4. The quadratus lumborum muscle.
5. The external condyle of the humerus.
6. The tendon of the triceps muscle.
7. The bicipital tubercle of the radius.
8. The gluteus medius muscle.
9. The pyriformis muscle.
10. The gemelli muscles.
11. The quadratus muscle.

Fig. 2. Diagram of the fore-arm and hand showing the extensor communis digitorum muscle.

1. The extensor profundus muscle.
2. The styloid process of the ulna.
3. The extensor tendons of the little finger.
4. The extensor tendons of the index finger.
5. The head of the radius.
6. The superficial extensor muscles of the fingers.
7. The styloid process of the radius.
8. The extensor tendons passing over the wrist joint.


Fig. 1
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Fig. 2.
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PLATE 45.

Diagrams of the skeleton of the right fore-arm and hand with the muscles of the forearm superposed.

Fig. 1. The two pronator muscles.

1. The external condyle of the humerus.
2. The pronator radii teres muscle.
3. The head of the radius.
4. The shaft of the radius.
5. The pronator quadratus muscle.
6. The styloid process of the radius.
7. The internal condyle of the humerus.
8. The coronoid process of the ulna.
9. The bicipital tubercle of the radius.
10. The shaft of the ulna.
11. The styloid process of the ulna.

Fig. 2. The long supinator muscle.

1. The external condyle of the humerus.
2. The head of the radius.
3. The bicipital tubercle of the radius.
4. The supinator longus muscle.
5. The attachment of the tendon of the supinator longus muscle.
6. The internal condyle of the humerus.
7. The coronoid process of the ulna.
8. The shaft of the ulna.
9. The styloid process of the ulna.

Fig. 3. The two flexor muscles of the wrist.

1. The external condyle of the humerus.
2. The head of the radius.
3. The flexor carpi radialis muscle.
4. The styloid process of the muscle.
5. The attachment of the tendons of the flexor carpi radialis.
6. The internal condyle of the humerus.
7. The coronoid process of the ulna.
8. The shaft of the ulna.
9. The styloid process of the ulna.

Fig. 4. The long flexor muscle of the thumb.

1. The internal condyle of the humerus.
2. The head of the radius.
3. The flexor longus pollicis muscle.
4. The tendon of the flexor longus pollicis muscle.
5. The attachment of the tendon of the flexor longus pollicis muscle.
6. The internal condyle of the humerus.
7. The coracoid process of the ulna.
8. The shaft of the ulna.
9. The styloid process of the ulna.

PLATE 45

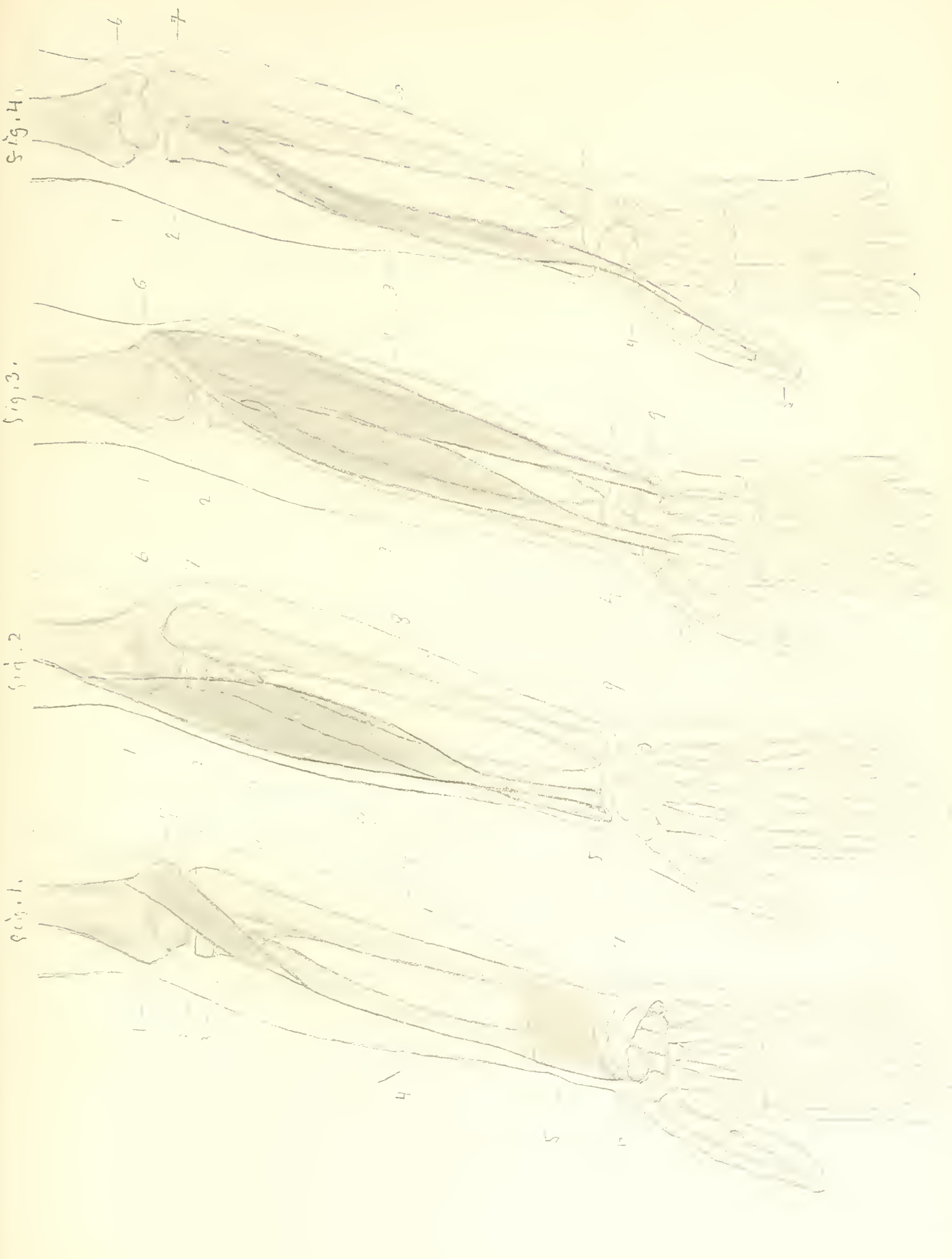


PLATE 46.

Diagrams of the skeleton of the right fore-arm and hand with the muscles superposed.

Fig. 1. The superficial flexor muscle of the fingers.

1. The external condyle of the humerus.
2. The bicipital tubercle of the radius.
3. The flexor sublimis digitorum muscle.
4. The tendons of the flexor sublimis passing over the carpus.
5. The splitting of the tendon at the first phalanx of the index.
6. The internal condyle of the humerus.
7. The coronoid process of the humerus.
8. The styloid process of the ulna.
9. The splitting of the tendons on the first phalanx of the little finger.

Fig. 2. The deep flexor muscle of the fingers.

1. The external condyle of the humerus.
2. The head of the radius.
3. The bicipital tubercle of the radius.
4. The flexor profundus digitorum muscle.
5. The tendons of the flexor profundus passing over the carpus.
6. The attachment of the deep tendon on the ungual phalanx of the index finger.
7. The internal condyle of the humerus.
8. The coronoid process of the ulna.
9. The attachment of the deep tendon over the ungual phalanx of the little finger.

Fig. 3. The three extensor muscles of the wrist.

1. The internal condyle of the humerus.
2. The extensor carpi ulnaris muscle.
3. The styloid process of the ulna.

Fig. 3—continued.

4. The attachment of the tendon of the extensor carpi ulnaris muscle.
5. The attachment of the tendon of the extensor carpi radialis muscle.
6. The external condyle of the humerus.
7. The position of the head of the radius.
8. The extensor carpi radialis longior muscle.
9. The extensor carpi radialis brevior muscle.
10. The styloid process of the radius.
11. The attachment of the tendon of the extensor carpi radialis longior muscle.

Fig. 4. The extensor muscle of the index finger and the three extensor muscles of the thumb.

1. The internal condyle of the humerus.
2. The olecranon process of the ulna.
3. The extensor indicis muscle.
4. The extensor primi internodii pollicis muscle.
5. The external condyle of the humerus.
6. The spinator radii brevis muscle.
7. The extensor ossi metacarpi pollicis muscle.
8. The extensor secundi internodii pollicis muscle.
9. The attachment of the extensor ossis metacarpi pollicis muscle.
10. The tendon of the extensor primi internodii pollicis muscle.
11. The attachment of the extensor secundi internodii pollicis muscle.


Fig. 4.
Fig. 3
Fig. 2
Fig. 1

PLATE 47.

Diagrams of the skeleton of the fore-arm and hand in various degrees of pronation (from photographs).

Fig. 1. The radius twisted over the ulna in pronation (*from the back*).

1. The cuneiform bone.
2. The unciform bone.
3. The styloid process of the ulna.
4. The trapezium.
5. The scaphoid bone.
6. The styloid process of the radius.

Fig. 2. The bones in same relative position as in Fig. 1 (*from the inner side*).

1. The os magnum.
2. The scaphoid bone.
3. The styloid process of the radius.

Fig. 3. The radius twisted over the ulna in pronation, the index finger extended as in pointing (*from the inner side*).

1. The trapezium.
2. The scaphoid bone.
3. The styloid process of the radius.

Fig. 4. The bones in the same relative position as in Fig. 1 (*from the palmar surface*).

1. The os magnum.
2. The semi-lunar bone.
3. The styloid process of the radius.
4. The pisiform bone.
5. The styloid process of the radius.

Fig. 1.

Fig. 2

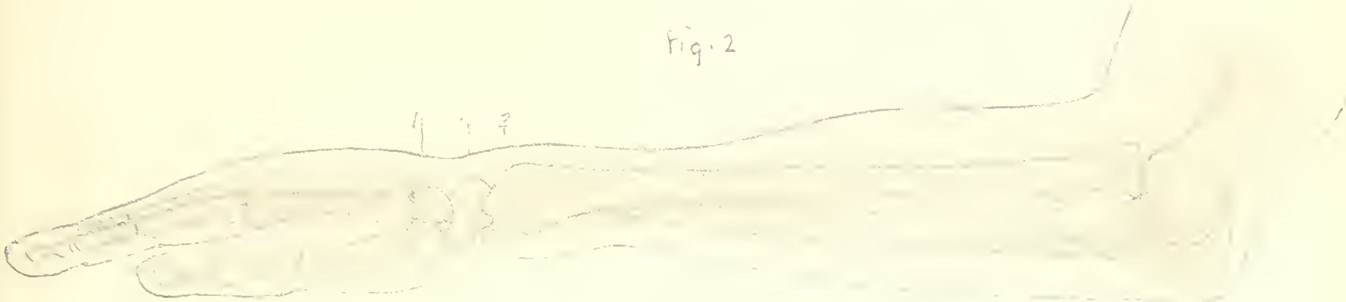


Fig. 3.

Fig. 4.

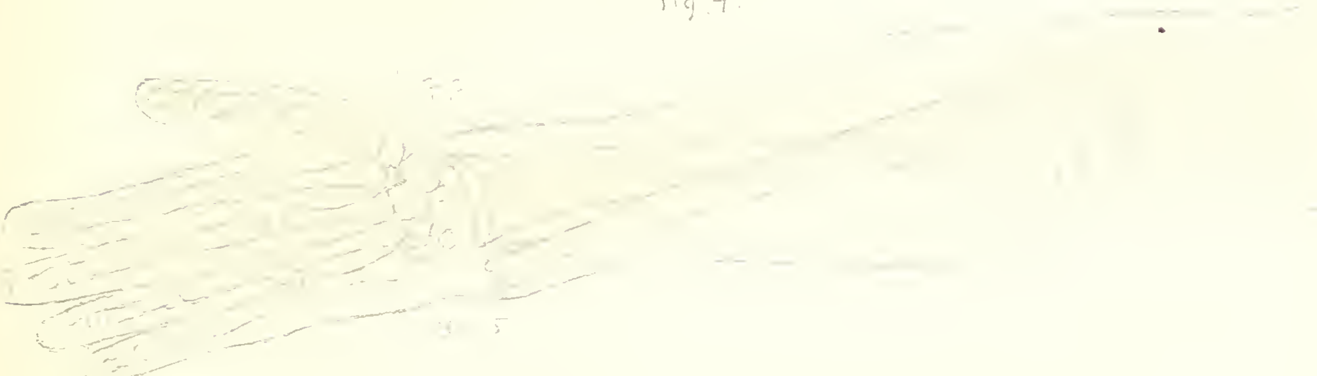


PLATE 48.

Fig. 1. Skeleton of the right fore-arm and hand (*from the back*) with the index finger pointing (from photograph).

1. The internal condyle of the humerus.
2. The shaft of the ulna.
3. The os magnum.
4. The knuckle joint of the middle finger.
5. The external condyle of the humerus.
6. The shaft of the radius.
7. The joint between the trapezium and metacarpal bone of the thumb.

Fig. 2. The palmar surface of the skeleton of the right hand, showing the abductor and adductor muscles of the thumb and abductor muscle of the little finger.

1. The abductor pollicis muscle.
2. The adductor pollicis muscle.
3. The semi-lunar bone.
4. The abductor minimi digiti muscle.

Fig. 3. The skeleton of the right hand, showing the opponens muscles of the thumb and little finger.

1. The opponens pollicis muscle.
2. The scaphoid bone.
3. The opponens minimi digiti muscle.

Fig. 4. The skeleton of the right hand, showing the three palmar interosseii muscles.

1. The trapezium.
2. The proximal digital bone of the thumb.
3. The palmar interosseous muscle of the index finger.
4. The palmar interosseous muscle of the ring finger.
5. The unciform bone.
6. The palmar interosseous muscle of the little finger.

Fig. 5. The skeleton of the right hand, showing the four dorsal interosseous muscles.

1. The unciform bone.
2. The dorsal interosseous muscle of the ring finger.
3. The dorsal interosseous muscle of the ulnar side of the middle finger.
4. The trapezium.
5. The dorsal interosseous muscle of the radial side of the middle finger.
6. The dorsal interosseous muscle of the index finger.

PLATE 48

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

PLATE 49.

Fig. 1. Diagram of all the muscles and tendons on the back of the right hand and wrist.

1. The superficial extensor tendon of the index finger.
2. The long extensor tendon of the thumb.
3. The dorsal interosseous muscle of the index finger.
4. The tendon of the extensor carpi radialis brevior muscle.
5. The tendon of the extensor carpi radialis longior muscle.
6. The annular ligament.
7. The extensor muscles of the thumb.
8. The dorsal interosseous muscles of the ring finger.
9. The dorsal interosseous muscle of the little finger.
10. The tendon of the extensor minimi digiti muscle.
11. The lower end of the radius.

Fig. 2. Drawing from a photograph of the skeleton of the back of the hand and wrist (with outline) to be compared with Fig. 1.

1. The trapezium.
2. The scaphoid bone.
3. The styloid process of the radius.
4. The os magnum.
5. The semi-lunar bone.
6. The styloid process of the ulna.

Fig. 3. Diagram showing all the tendons and muscles on the palmar surface of the right hand.

1. The splitting of the superficial flexor tendon to show the deep flexor tendon of the ring finger.
2. The palmar interosseous muscle of the ring finger.
3. The flexor tendon of the little finger.
4. The abductor minimi digiti muscle.
5. The opponens minimi digiti muscle.
6. Position of the head of the meta-carpal bone of the middle finger.
7. The splitting of the superficial flexor tendon of the middle finger.
8. The palmar interosseous muscle of the middle finger.
9. The adductor pollicis muscle.
10. The opponens pollicis muscle.
11. The abductor pollicis muscle.
12. The position of the trapezium.

Fig. 4. Drawing from a photograph of the skeleton of the right hand, with outline (palmar surface); to be compared with Fig. 3.

1. The ungual phalanx of the ring finger.
2. The meta-carpal bone of the middle finger.
3. The semi-lunar bone.
4. The styloid process of the radius.
5. The proximal phalanx of the middle finger.
6. The trapezium.
7. The scaphoid bone.
8. The styloid process of the radius.

PLATE 49

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

PLATE 50.

Fig. 1. Diagram showing the relations of the interosseous muscles to the superficial flexor tendons on the palm of the right hand.

1. The annular ligament.
2. The superficial flexor tendon.
3. The trapezium.
4. The interosseous muscle to the index finger.
5. The interosseous muscle to the middle finger.
6. The interosseous muscle to the little finger.
7. The interosseous muscle to the ring finger.

Fig. 2. Diagram showing the palmar fascia on the right hand.

1. The annular ligament.
2. The slip from the palmar fascia to the ball of the thumb.
3. The abductor pollicis muscle.
4. The adductor pollicis muscle.
5. The cut border of the skin of the palm, showing the loops of the palmar fascia at the clefts of the finger.
6. The palmar brevis muscle.
7. The sheath of the muscles of the balls of the thumb.
8. The palmar fascia.

Fig. 3. Drawing of the skeleton of the right hand and wrist with the index finger pointing; to be compared with Fig. 4.

1. The ungual phalanx of the index finger.
2. The intermediary phalanx of the index finger.
3. The proximal phalanx of the index finger.
4. The knuckle joint of the middle finger.
5. The meta-carpal bone of the index finger.
6. The scaphoid bone.

Fig. 3—continued.

7. The lower end of the radius.
8. The ungual phalanx of the thumb.
9. The proximal phalanx of the thumb.
10. The meta-carpal bone of the thumb.
11. The trapezium.
12. The shaft of the ulna.
13. The annular ligament.
14. The tendon of the superficial common extensor muscle to the fingers.

Fig. 4. Drawing of the right hand as in Fig. 3, showing the relations of the tendons and muscles to the index finger and thumb.

1. The extensor tendon passing to the ungual phalanx of the index finger.
2. The blending of the tendon of the interosseous muscle with the extensor tendon of the index finger.
3. The meta-carpal bone of the index finger.
4. The dorsal interosseous muscle of the middle finger.
5. The trapezoid bone.
6. The scaphoid bone.
7. The annular ligament.
8. The middle extensor tendon of the thumb.
9. The outer extensor tendon of the thumb.
10. The insertion of the tendon of the long extensor muscle of the thumb.
11. The adductor pollicis muscle.
12. The tendon of the long extensor muscle of the thumb.
13. The tendon of the short extensor muscle of the thumb.
14. The tendon of the extensor muscle to the meta-carpal bone of the thumb.
15. The os magnum.
16. The wrist joint.
17. The flexor tendons.

Fig. 1.

Fig. 2.

Fig. 3.

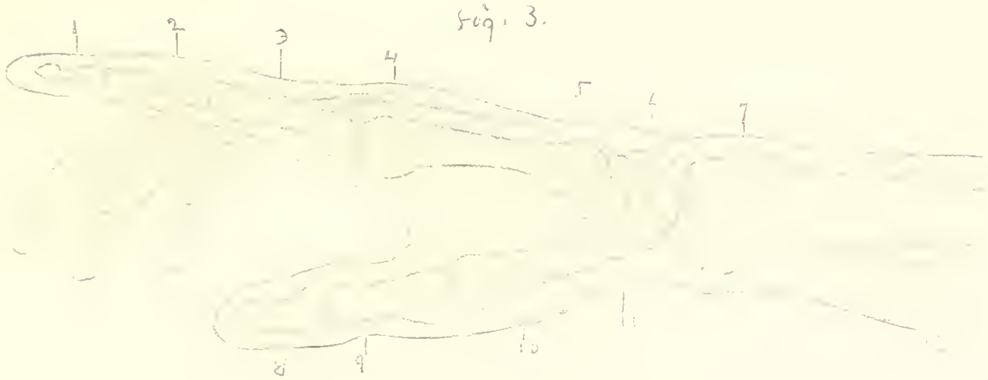


Fig. 4.

PLATE 51.

Fig. 1. Photograph of the palmar surface of the skeleton of the right hand of a woman.

1. The scaphoid bone.
2. The trapezium.
3. The trapezoid.
4. The meta-carpal bone of the thumb.
5. The first phalanx of the thumb.
6. The ungual phalanx of the thumb.
7. The meta-carpal bone of the index finger.
8. The first phalanx of the index finger.
9. The second phalanx of the index finger.
10. The ungual phalanx of the index finger.
11. The semi-lunar bone.
12. The cuneiform bone.
13. The os magnum.
14. The unciform and pisiform bones.
15. The meta-carpal bone of the little finger.
16. The first phalanx of the little finger.
17. The second phalanx of the little finger.
18. The third or ungual phalanx of the little finger.

Fig. 2. Photograph of the palmar surface of the skeleton of the right hand of a man. The numbers indicate the same bones as in Fig. 1.

Fig. 3. Photograph of the dorsal surface of the skeleton of the right hand of a woman.

1. The semi-lunar bone.
2. The cuneiform bone.
3. The os magnum.
4. The unciform bone.
5. The meta-carpal bone of the little finger.
6. The first phalanx of the little finger.
7. The second phalanx of the little finger.
8. The ungual phalanx of the little finger.
9. The scaphoid bone.
10. The trapezoid.
11. The trapezium.
12. The meta-carpal bone of the thumb.
13. The first phalanx of the thumb.
14. The ungual phalanx of the thumb.

Fig. 3—continued.

15. The first phalanx of the index finger.
16. The second phalanx of the index finger.
17. The ungual phalanx of the index finger.

Fig. 4. Photograph of the dorsal surface of the skeleton of the right hand of a man. The numbers indicate the same bones as in Fig. 3.

Fig. 5. Photograph of the skeleton of the right hand of a woman (*inner side*).

1. The ungual phalanx of the index finger.
2. The second phalanx of the index finger.
3. The first phalanx of the index finger.
4. The meta-carpal bone of the middle finger.
5. The unciform bone.
6. The semi-lunar bone.
7. The ungual phalanx of the middle finger.
8. The ungual phalanx of the ring finger.
9. The ungual phalanx of the little finger.
10. The ungual phalanx of the thumb.
11. The first phalanx of the thumb.
12. The meta-carpal bone of the thumb.
13. The scaphoid bone.

Fig. 6. Photograph of the skeleton of the right hand of a woman (*outer side*).

1. The scaphoid bone.
2. The trapezoid.
3. The os magnum.
4. The meta-carpal bone of the index finger.
5. The second phalanx of the index finger.
6. The ungual phalanx of the index finger.
7. The trapezium.
8. The meta-carpal bone of the thumb.
9. The first phalanx of the thumb.
10. The ungual phalanx of the thumb.
11. The first phalanx of the index finger.
12. The ungual phalanx of the little finger.
13. The ungual phalanx of the ring finger.
14. The ungual phalanx of the middle finger.

PLATE 51

Fig. 1

Fig. 2

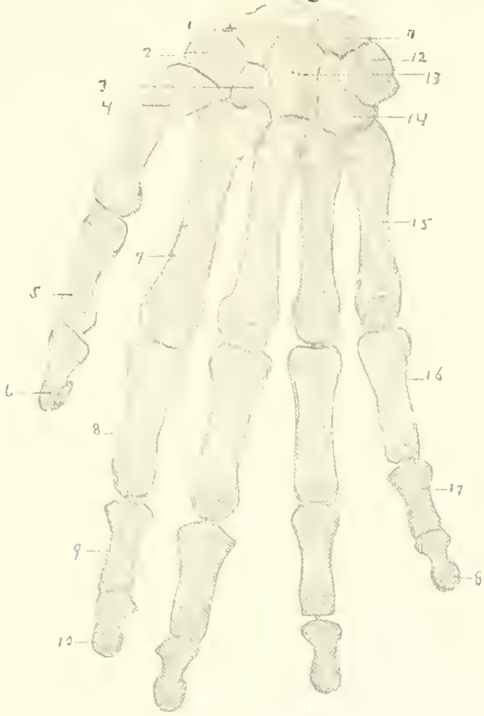


Fig. 6

Fig. 3

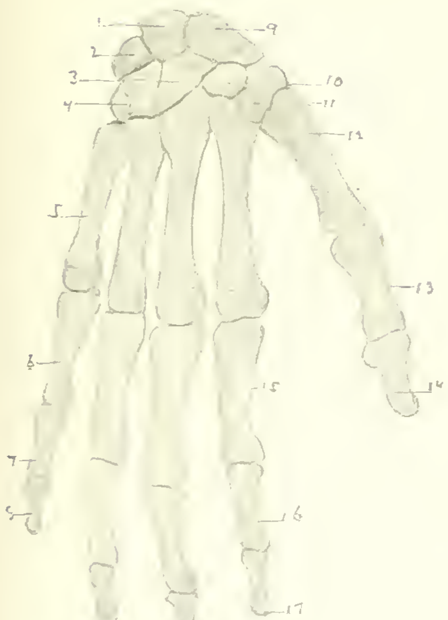
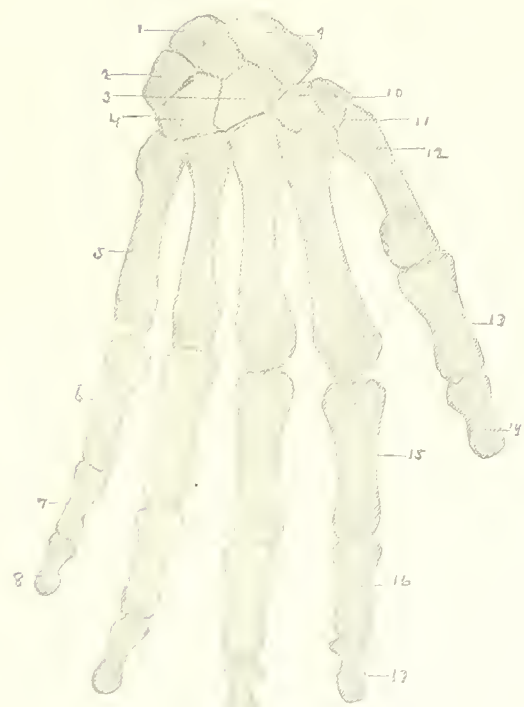


Fig. 4



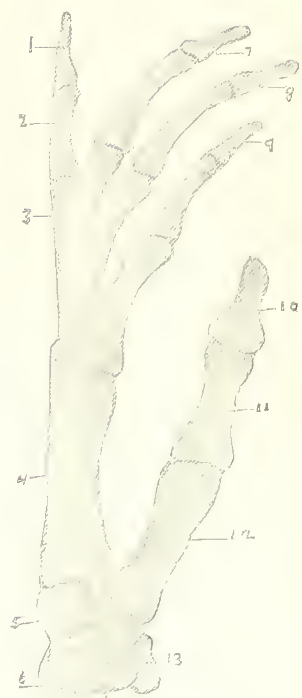


Fig. 5

PLATE 52.

Photographs of a man's hand in various positions.

Fig. 1. The palmar surface of the right hand with the fingers outstretched to show the surface markings.

Fig. 2. The dorsal surface of the right hand (same as Fig. 1).

Fig. 3. The thumb side of the right hand as in an ordinary gesture.

Fig. 4. The palmar surface of same hand as in Fig. 3—showing the relations of the fingers.

Fig. 5. The thumb side of the right hand with the index finger as in pointing.

Fig. 6. The dorsal surface of the hand in the same position as in Fig. 5.

PLATE 52

Fig. 1

Fig. 3

Fig. 4

Fig. 2

Fig. 5

Fig. 6

PLATE 53.

Photographs of a man's hand in various positions.

Fig. 1. The right hand in a receptive position, showing the markings on the palmar surface.

Fig. 2. The thumb and back view of the left hand extended as in surprise.

Fig. 3. The right hand with the fingers closed on the palm as in grasping.

Fig. 4. The palmar surface of the right hand with the fingers separated as in the attitude of one imploring.

Fig. 5. The right hand as in pressing against an object to assist in maintaining equilibrium.

Fig. 6. The back of the right hand extended as in negation.

PLATE 53

Fig. 1

Fig. 4

Fig. 2

Fig. 5

Fig. 3

Fig. 6

THE PELVIS.

THE *pelvis* (basin) (Plate 25) is the lower portion of the trunk. It is peculiarly constructed, so that it serves not only to protect the viscera which it contains, and to support some of the viscera of the abdomen, (Plate 31, Fig. 1), but also to transmit the weight of the body to the lower extremities. It also affords attachment to the muscles which steady the trunk and move the thighs.

In the adult the pelvis consists of four bones: the right and left innominate bones, the sacrum and the coccyx. These bones are arranged in the form of an oblique arch, with broadly expanded wings. The innominate bones join with each other in front of the pubis, and receive the sacrum between them behind in the manner of a keystone to an arch, constituting the *pelvic girdle*, which is a rigid portion of the trunk and altogether unlike the movable shoulder girdle (Plate 38, Figs. 14 and 15).

The pelvis undergoes alteration in form and obliquity from infancy to puberty in accordance with its adaptation to the transmission of the weight of the body in the standing and sitting postures. The obliquity of the pelvic arch assists in distributing the effects of shocks received from below, as in jumping.

Each *innominate bone* (haunch or hip bone) is an irregularly shaped bone which before puberty is composed of three portions, the ilium, the ischium, and the pubis. They meet at the acetabulum, which is the large cup-shaped cavity for the reception of the head of the femur, or thigh bone (Plate 7, Fig. 5). The prominences of the innominate bones are constantly referred to as landmarks. The broad expanded portion which supports the flank is formed by the ilium; its margin, or *crest*, is subcutaneous and presents at each end a *superior spinous process* (Plate 54, Fig. 2, and Plate 55, Fig. 2).

The *ischium* is the inferior and strongest portion of the innominate bone. It consists mainly of a large rough mass, the *tuberosity*, upon which the weight of the body is received in the sitting position (Plates 71, 72, 75 and 84).

The *pubis* is the front part of the innominate bone and joins with the corresponding portion of the opposite bone, their junction being called the

symphysis (Plate 54, Fig. 1). Between the ischium and the pubis there is a large aperture, the obturator foramen, which gives lightness without diminishing the strength of the pelvis. The *obturator foramen* is an irregular oval in the male, while in the female it is shorter and broader, and triangular in shape (Plate 54, Fig. 2, and Plate 55, Fig. 2).

The *sacrum* and the *coccyx* belong essentially to the vertebral column (page 49) and form, when taken together, the back wall of the *pelvic cavity* (Plate 24, Fig. 1). In childhood the sacrum consists of five separate *sacral vertebræ* which decrease in size from above downward. At puberty the intervertebral disks of cartilage become ossified, and the component vertebræ are consolidated into one bony mass.

The *coccyx* (Plate 38, Fig. 15) is originally composed of four or five rudimentary vertebræ which, after adult age, usually consolidate into one or two pieces. It is the caudal appendage of the skeleton.

The *pelves of the adult male and female* present many points of contrast. The bones of the male pelvis (Plate 55, Figs. 1 and 2) after puberty are always rougher and more massive, and its cavity is deeper and narrower than in the female pelvis (Plate 54, Figs. 1 and 2), the bones of which are more expanded, and the cavity is shallower and more capacious, owing to the greater width of the *pubic arch*; to the sacrum being less curved, and to the ischial tuberosities being everted. The acetabula, and consequently the heads of the thigh bones, are further apart in the female than they are in the male (Plates 2, 4 and 6).

PLATE 54.

Drawings from Photographs.

Fig. 1. The female pelvis (*from above*).

1. The right ilium.
2. The cavity of the pelvis.
3. The right acetabulum.
4. The obturator foramen.
5. The right ischium.
6. The left ilium.
7. The sacrum.
8. The coccyx.
9. The left acetabulum.
10. The left ischium.

Fig. 2. The female pelvis (*from the right side*).

1. The ilium.
2. The sacrum.
3. The coccyx.
4. The great sciatic foramen.
5. The ischium.
6. The acetabulum.
7. The pubis.
8. The obturator foramen.

Fig. 3. The right femur or thigh bone (*from the front*).

1. The head.
2. The greater trochanter.
3. The upper portion of the shaft.
4. The lower portion of the shaft.
5. The external condyle.
6. The patellar surface.
7. The neck.
8. The lesser trochanter.
9. The adductor tubercle.
10. The internal condyle.

Fig. 4. The right femur (*from the back*).

1. The neck.
2. The lesser trochanter.
3. The upper portion of the shaft.
4. The linea aspera.
5. The lower portion of the shaft.
6. The adductor tubercle.
7. The internal condyle.
8. The head.
9. The greater trochanter.
10. The external condyle.

Fig. 5. The right femur (*from the outer side*).

1. The head.
2. The greater trochanter.
3. The lesser trochanter.
4. The shaft.
5. The external condyle.
6. The neck.

Fig. 6. The right femur (*from the inner side*).

1. The head.
2. The internal condyle.
3. The depression for the attachment of the ligamentum teres.
4. The lesser trochanter.
5. The shaft.
6. The external condyle.

PLATE 54

Fig. 1.

Fig. 2.

Fig. 3

Fig. 4.

Fig. 5

Fig. 6

PLATE 55.

Drawings from Photographs.

Fig. 1. The male pelvis (*from above*).

1. The right ilium.
2. The sacrum.
3. The cavity of the pelvis.
4. The right acetabulum.
5. The coccyx.
6. The obturator foramen.
7. The right ischium.
8. The left ilium.
9. The left acetabulum.
10. The left ischium.

Fig. 2. The male pelvis (*from the right side*).

1. The ilium.
2. The sacrum.
3. The coccyx.
4. The sciatic notch.
5. The ischium.
6. The acetabulum.
7. The pubis.
8. The obturator foramen.

Fig. 3. The patella and bones of the leg, tibia and fibula (*from the front*).

1. The patella.
2. The head of the tibia.
3. The head of the fibula.
4. The shaft of the fibula.
5. The lower end of the fibula, or external malleolus.
6. The tubercle of the tibia.
7. The crest of the tibia.
8. The lower end of the tibia, or internal malleolus.

Fig. 4. The patella, tibia and fibula (*from the back*).

1. The patella.
2. The head of the tibia.
3. The oblique line.
4. The shaft of the tibia.
5. The internal malleolus.
6. The head of the fibula.
7. The shaft of the fibula.
8. The external malleolus.

Fig. 5. The patella, tibia and fibula (*from the outer side*).

1. The patella.
2. The head of the tibia.
3. The head of the fibula.
4. The shaft of the fibula.
5. The external malleolus.
6. The tubercle of the tibia.
7. The shaft of the tibia.
8. The lower end of the tibia.

Fig. 6. The patella, tibia and fibula (*from the inner side*).

1. The patella.
2. The head of the tibia.
3. The shaft of the tibia.
4. The lower end of the tibia.
5. The head of the fibula.
6. The shaft of the fibula.
7. The external malleolus.

Fig. 1.

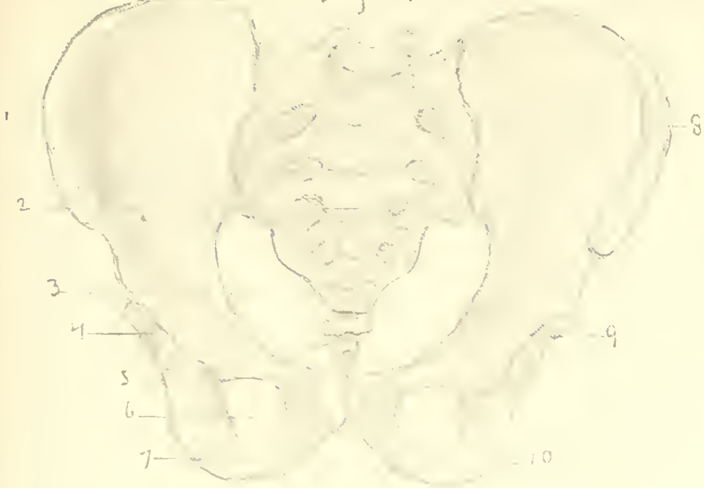


Fig. 2.

Fig. 3.

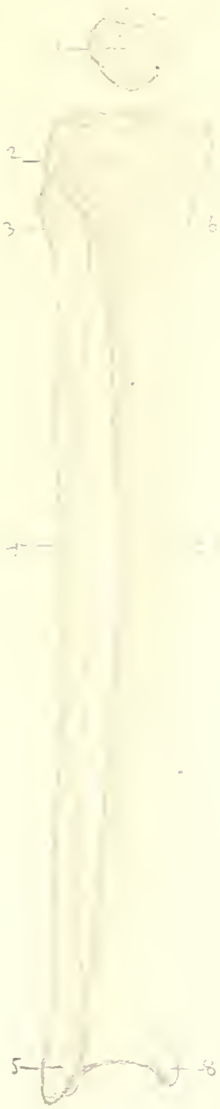


Fig. 4.

Fig. 5.

Fig. 6.

THE LOWER EXTREMITY.

THE *skeleton of the lower extremity* (Plates 2, 4 and 6) consists of the innominate bone, the femur, the tibia, and the fibula, the tarsal, the meta-tarsal, and the digital bones.

The innominate bone is one of the component bones of the pelvis, and is described on page 89.

The *femur*, (Plate 54, Figs. 3, 4, 5 and 6) the single bone of the thigh, is the longest and strongest bone of the entire skeleton, and presents an excellent illustration of the combined influence of gravity and muscular force; its general character and development determining the stature. The natural position of the femur in the erect posture is more or less oblique, depending upon the angle formed between the head of the bone and its neck, and the width of the pelvis. The degree of obliquity therefore varies in different individuals, being adapted in each to the transmission of the superincumbent weight of the body, so that in walking each limb may be alternately brought into the line of the centre of gravity (Plate 103). The obliquity is best appreciated if the two femora are examined in an articulated skeleton, where they will be seen to converge toward the knees, where they form angles of ten degrees with the bones of the corresponding legs, which are straight (Plates 2, 4, 31 and 56).

The *upper end of the femur* (Plate 54) consists of a head and neck and two rough processes called the greater and lesser trochanters. The *head* is the globular portion which, in the erect position, is directed upward, inward, and a little forward, to be received into the acetabulum, the large cup-shaped cavity of the innominate bone. The *neck* is the portion of the bone which connects the head with the shaft, and varies in length and obliquity. In the adult male (Plates 2 and 56) it forms an angle of about one hundred and twenty-five degrees with the shaft; in the adult female (Plate 4), owing to the greater width of the pelvis, the angle is somewhat less.

The *greater trochanter* is the irregular quadrilateral projection upward and outward from the shaft, and the *lesser trochanter*, of variable shape, is the projection from the lower and posterior part of the base of the neck (Plate 54).

The shaft of the femur is curved with a smooth anterior convexity which in the lower part gradually flattens as it expands at the knee. There is a decided twist in the shaft which causes a change in the relative bearing of the anterior surface, so that above it is directed forward and outward, while below it is directed forward and inward. The posterior surface of the shaft presents a longitudinal roughened ridge, called the *linea aspera*, which consists of two slightly raised borders with an intermediate furrow. The two borders of the linea aspera in the upper portion of the shaft diverge toward the bases of the greater and lesser trochanters, while in the lower portion they again diverge toward the external and internal condyles, thereby forming the popliteal surface. The lower end of the femur consists of two ovoidal *condyles* which are separated by a deep notch (Plate 54). The condyles blend in front, forming a smooth *trochlear surface* for the easy play of the patella in the extension and flexion of the knee joint. Both condyles are on the same level when the bone is in its natural position, although the inner condyle is longer than the outer. The great trochanter and the condyles of the femur serve as landmarks because they are sub-cutaneous. The shaft, like that of the humerus, although completely surrounded by the soft structures which it supports, contributes to the curved form of the thigh, which is always convex in front (Plate 61).

The bones which constitute the *knee joint* are the lower end of the femur with the patella superposed upon its condyles, and the upper end of the tibia.

The *patella, or knee pan* (Plate 55), is a flattened triangular bone placed with its apex downward in front of the knee and so disposed that its lower articular surface rests upon the trochlear of the femur, to a variable extent depending upon the degree of the extension or flexion of the knee joint. In the female the patella is proportionately wider than it is in the male. It should be understood that the whole of the articular surface of the patella is never in contact with the femur. The greatest extent to which the surfaces are brought in apposition occurs when the joint is in the mid position between extension and flexion. When the leg is extended and the foot rested so that there is no strain upon the extensor muscles, the patella is freely movable. Its function, besides affording protection to the front of the knee joint, is to increase the leverage of the great extensor muscle on the front of the thigh. The varying positions

and relations of the patella should be carefully studied, in comparison with the corresponding bone of the opposite limb, which is at all times a ready and valuable guide for reference.

The two bones, the tibia and the fibula, which compose the skeleton of the leg (Plate 55, Figs. 3, 4, 5 and 6, and Plates 63 and 65), are joined almost immovably together at the upper and lower ends.

The *tibia* is the innermost and strongest, sustaining the entire weight of the body in the erect position, while the fibula is upon the outer side and is very slender, serving to give attachment to muscles, and contributing by its lower end, with that of the tibia, to the formation of the ankle joint. They are nearly parallel, but as the tibia is bowed slightly forward and the fibula backward, there is a difference in the relative bearing of the planes of their surfaces, so that the fibula occupies a posterior position to that of the tibia (Plate 63). The upper end of the tibia (Plate 55) is expanded and about twice as broad as the lower end. It consists of an outer and inner tuberosity, separated at the back by a shallow notch. In front the two tuberosities are continuous with each other, and about an inch below the articular surfaces there is a prominent elevation called the *tubercle of the tibia*. The articular surfaces are smooth and concave for articulation with the condyles of the femur. Behind the external tuberosity there is an articular facet for the head of the fibula. The shaft of the tibia is, in a greater part of its extent, three-sided. It gradually decreases in size to the commencement of the lower fourth, where it expands at the ankle. The inner surface is flat and sub-cutaneous and is commonly called the *shin*. It is the largest sub-cutaneous area of bone in the entire skeleton.

The posterior surface of the tibia presents about a hand's breadth below the knee an oblique line called the *linea solea* (Plate 55, Fig. 4, and Plate 65, Fig. 2). The lower end of the tibia gradually expands into a quadrilateral mass from which a strong process projects from the inner side, constituting the *internal malleolus*, which descends below the level of the ankle joint and is a conspicuous landmark.

The *fibula* (peroneal or splint bone) is the most slender of all the long bones of the skeleton. Its length about equals that of the tibia, but as its upper end is articulated with the outer tuberosity of that bone below the knee joint, its

lower end, forming the *external malleolus*, projects considerably below the internal malleolus, formed by the lower end of the tibia.

The contiguous borders of the two bones of the leg are connected by an *interosseous membrane* similar to that in the forearm (page 73). The two bones of the leg, as already stated, are connected by ligaments above and below, and although the movements between them are very slight, they are of exceeding importance. The fibula is the movable bone, and the yielding of this bone at its upper and lower attachments prevents injury from shocks received from below, as when the body-weight is received upon the feet in jumping or leaping from a height.

The *skeleton of the foot* (Plates 63, 65, 68 and 69) consists of the heel, or *tarsus*, the median portion, or *meta-tarsus,* and the *phalanges*, or bones of the toes.

In general arrangement the bones of the different portions of the foot correspond to those of the hand, but they are especially modified so as to adapt them to firmness and strength rather than to mobility.

The *tarsus* is greater in length than the meta-tarsus, while the meta-tarsus is longer than the phalanges, which is the reverse of the relative proportion of their analogues in the hand. The plantar surface is always normally turned downward and the dorsal surface upward, the foot being, consequently, in a permanent position of pronation and over-extension.

There are seven *tarsal bones* which are short and thick and arranged in three groups (Plate 68, Fig. 1, and Plate 69, Fig. 4). The posterior group consists of the astragalus and the os calcis; the central of the scaphoid, and the anterior of the cuboid and three cuneiform bones. The dorsal surfaces of the tarsal bones are smoother than the plantar surfaces, which are grooved for the play of the flexor tendons (Plate 69). The contiguous surfaces of the tarsal bones form gliding joints with one another, but the degree of motion is even less than that between the corresponding carpal bones. There is, however, considerable rotation as well as abduction and adduction between the astragalus and the os calcis which should not be confounded with the motion of the ankle joint above.

The *astragalus* is the uppermost bone of the tarsus and the only one in direct contact with the bones of the leg (Plate 63), and the *ankle joint* is formed

by its trochlear surface being received against the lower end of the tibia and articulating by its two lateral facets with the malleolus of the tibia upon the inner side, and with the malleolus of the fibula upon the outer side. It is a hinge joint which is surrounded by a capsular ligament, and strengthened upon the sides by special lateral ligaments and by the many tendons which surround it (Plate 9, Figs. 7 and 8).

The *os calcis*, or *calcaneum*, is the largest and strongest of the tarsal bones. It is beneath the astragalus and projects backward to a variable extent in different individuals, forming the *heel*. The tendon of Achilles is attached to its roughened posterior part. The inner surface projects inwardly, forming the *sustentaculum tali* (Plate 68, Fig. 1) which supports the astragalus. Owing to this formation of the bone there is a deep concavity on the internal surface which allows the flexor tendons to pass to the sole of the foot (Plate 64, Fig. 2). The character and relations of the rest of the tarsal bones can be understood by referring to the plates where they are shown from different points of view.

There are five *meta-tarsal bones* which in general construction resemble the meta-carpal bones of the hand. The shafts are slightly curved longitudinally, presenting, when in position, a convex surface above and a concave surface below. The first or meta-tarsal bone of the great toe is peculiar for its great thickness and for its being shorter than the other meta-tarsal bones. Its shaft is very strong and is prismoid in form, and the head is large, being provided on the plantar surface with grooves for the sesamoid bones (page 110). The second meta-tarsal bone is the longest of the series, its head advancing beyond the heads of all the others. Its base is peculiarly lodged between the three cuneiform bones (Plate 63, Fig. 3). The fifth or meta-tarsal bone of the little toe has a very small head, and a base which is peculiar for the rough tuberosity which projects outwardly, and is a prominent feature.

The *phalanges* are, as in the hand, two in the great toe and three in each of the other toes. They are all shorter than the phalanges in the fingers. The first phalanx in the great toe is the largest, and the others decrease in size in succession to that of the little toe. The second phalanges are all comparatively very short. The third, or ungual, phalanges are shaped a great

deal like those of the fingers, only smaller. The ungual phalanx of the great toe is much the largest. The joints between the phalanges are capable of greater dorsal extension than the corresponding joints in the fingers, and can be similarly flexed, abducted and adducted, During flexion the toes have a decided tendency to converge.

When the entire skeleton of the foot (Plate 63) is examined it will be seen that the narrowest part is formed by the projection backward of the os calcis, (the heel), that it widens at the heads of the meta-tarsal bones (the balls of the toes), and that the arrangement of the bones between these points produces an *antero-posterior*, or *longitudinal, arch*. This is of great importance, as it contributes to the grace and freedom of movement of the foot. The points of support, or buttresses of the arch, are formed by the os calcis behind, and the under surface of the head of the meta-tarsal bone of the great toe upon the inner side in front, while the tuberosity of the meta-tarsal bone of the little toe is another, although weaker support, on the outer side. The highest point of the arch corresponds to the joint between the astragalus and scaphoid bones. It is called the *instep*, and it is also the weakest part of the arch. Under the instep on the plantar surface there is a ligament which is composed chiefly of elastic fibres, and this arrangement allows the arch to yield slightly, so that the foot can resist shock received upon its anterior surface. It moreover contributes to the springy action of the foot, so essential in active exercise.

The weight of the body is chiefly received upon the arch extending between the heel and the ball of the great toe. Besides the longitudinal arch the foot presents, beneath the instep, a *transverse half arch*, so that the half arches of the two feet, when they are placed together upon the ground in the erect position, may be considered as forming a complete arch. This is of great importance, because it serves as a firm basis of support and equally distributes the weight transmitted through the two legs.

When the *imprint* of a wet foot upon a smooth floor is examined, the broad impressions made by the heel and the balls of the toes are generally connected on the outer side by a band which is broader or narrower according to the development of the longitudinal arch. The impression of the entire sole will be made if the bridge of the instep is low, as in flat-footed people; while in those whose arched insteps are very high, the only impression thus

made corresponds to the heels and the balls of the toes, the intervening portions of the sole hardly touching the surface upon the outer side. It should be understood that the maintenance of the natural longitudinal arch, as well as the half arch of the foot, is due not only to the conformation of the bones, but also to the peculiar ligaments and tendons of the plantar surface of the foot (Plates 68 and 69). It should also be recognized that the foot spreads out when the weight of the body is received upon it, so that the shape and size of the foot differ according to whether or not it is subjected to pressure. This is very distinctly indicated in the Flying Mercury.

The *hip joint* is formed by the adaptation of the head of the femur to the acetabulum in the innominate bone, and is a much more perfect ball and socket joint than that formed at the shoulder by the head of the humerus and the glenoid cavity of the scapula (Plates 56 and 61). The general functions of the ligaments of the hip joint are described on page 23, and the ligaments are shown on Plate 7, Figs. 4, 5 and 6. In this connection the Y-shaped ilio-femoral ligament requires particular consideration, because it mainly economizes muscular effort in balancing the trunk. In this it is considerably aided by the atmospheric pressure, which is sufficient to hold the bones together at the hip after the severance of all the ligaments and overlying muscles.

The Y-ligament is the chief factor in preventing extreme backward extension of the thigh on the trunk, so that the erect posture can be prolonged by the mechanical locking of the hip joint through the tenseness of the ligament alone. In the ordinary erect position, with the heels together, called the "military position," the centre of gravity is behind the axes of the hip joints. If this is changed by stooping forward so as to fall in front of the hips, the position cannot be long endured, because the ligament is proportionately relaxed and the strain is counteracted, especially by the muscles of the buttocks and the back of the thighs.

In standing on one leg, with the weight received solely or mostly upon it, it is possible to extend the other leg backward so as to touch the ground with the toes. This is due to the fact that the centre of gravity of the body falls behind the hip joint of the limb bearing the weight, and that the

joint itself is in a state of flexion, the Y-ligament not being tense, and the equilibrium is established by the counterpoise of the opposite limb extended behind the line of gravity. This is illustrated in the act of walking up and down stairs (Plate 104). In this connection it should be noted that the movement forward (flexion) at the hip joint, by which the front of the thigh can be brought in contact with the front of the abdomen, depends upon the simultaneous bending of the knee joint. The degree to which the knee is flexed regulates the degree to which the corresponding hip joint can be flexed, because of the counteraction of the flexor muscles on the back of the thigh, called the hamstring muscles (page 107). For the same reason it is not easy to touch the toes without bending the knees (Plate 23, Fig. 4). The movements of adduction, abduction, and rotation, which are also possible at the hip joint, are affected by the various muscles of this region, and are limited either by the action of the ligaments or by the interference of the acetabulum with the neck of the femur in certain positions.

The muscles surrounding the hip joint are the ilio-psoas in front (Plate 43, Fig. 2), the rectus femoris and the gluteus minimus externally (Plate 57), the pyriformis, the two obturators, the two gemelli, and the quadratus behind (Plate 59), and the pectineus internally (Plate 57).

The great masses of muscles, with the overlying integument covering the hip joints posteriorly, are called the *buttocks*. They are peculiar to man, being consequent upon the erect position which he naturally assumes. Each buttock is limited by the crest of the ilium above, and the fold which forms a remarkable curve below, across the back of the upper part of the thigh (Plate 6).

The *buttocks* are formed chiefly by the three *glutei muscles*.

The *gluteus maximus* muscle (Plate 60, Fig. 2) is the largest fleshy mass in the body. It is very thick, and composed of coarse bundles of fibres which arise from the posterior portion of the ilium and from the spines of the sacrum and coccyx. Its fibres pass obliquely to be inserted into the *fascia lata* (page 105), on the outer part of the thigh, and crossing over the great trochanter blend with the sheath of the vastus externus muscle. The lower margin of the gluteus maximus forms the *gluteal fold* (Plates 6 and 42).

Action of the gluteus maximus muscle.—This muscle abducts the thigh and rotates it outward, making tense the fascia lata. It extends the thigh bone upon the pelvis, and thus serves to raise the body from the sitting to the erect position. In walking (Plates 104 and 105), it acts from the thigh to the pelvis, maintaining the body upright. It also aids in propelling the body in running and leaping.

The *gluteus medius muscle* (Plate 59, Fig. 2) is beneath the former muscle. Its fibres arise from the ilium below the crest of the bone and converge to a flat tendon which is attached to the upper and outer surface of the great trochanter.

Action of the gluteus medius muscle.—Acting from the ilium it abducts the thigh and rotates it inward; while acting from the great trochanter it extends the pelvis outward, assisting in balancing it when standing on one leg.

The *gluteus minimus muscle* (Plate 59, Fig. 1) arises from the lower and back surface of the ilium, and its tendon is attached to the front and outer part of the great trochanter.

Action of the gluteus minimus muscle.—It chiefly serves to augment the function of the other muscles of the buttock. It abducts the thigh when acting from the ilium and assists the gluteus medius in rotating the thigh inward.

It should be noticed that there is a V-shaped interval between the tensor fasciæ and the gluteus maximus muscles (Plate 62, Fig. 1). This interval is occupied by the gluteus medius muscle, which is of great importance in walking and running as it supports the trunk on the limb upon which the weight is received while the opposite limb is not in contact with the ground.

The *ilio-psoas muscle* is described on page 61.

The *pyriformis muscle* (Plate 59, Fig. 1) is below the gluteus medius. It arises within the pelvis by digitations from between the sacral foramina, passes out through the great sciatic notch, and is inserted by a tendon into the upper border of the great trochanter.

Action of the pyriformis muscle.—It assists in rotating the thigh outward.

The *obturator internus muscle* and the *two gemelli muscles* (Plate 59, Fig. 1) are deep-seated. The former arises within the pelvis, and as its tendon passes out of the lesser sciatic notch it is reinforced by the two gemelli muscles, and the combined tendon resulting is inserted into the great trochanter below the pyriformis.

Action of the obturator and gemelli muscles.—The chief action of these three muscles is to rotate the thigh outward; but when the body is in the sitting position they become abductors of the thigh.

The *obturator externus muscle* (Plate 57, Fig. 1) arises from the pubes, and its tendon blends with that of the quadratus femoris muscle.

Action of the obturator externus muscle.—It serves to rotate the thigh outward, and also assists the adductor muscles and is regarded as properly belonging to that group.

The *quadratus femoris muscle* (Plate 59, Fig. 1) arises from the tuberosity of the ischium and is inserted at the back of the great trochanter.

Action of the quadratus femoris muscle.—It assists in rotating the thigh outward.

The skin over the buttock is thick, coarse, and peculiarly provided with fat in the sub-cutaneous fascia, which is usually more developed in females than in males. The buttocks are separated from each other by a deep median groove which extends from the hollow or small of the back to the perineum. The changes in the position of the lower extremities naturally affect the surface forms of the buttocks. The gluteal fold which separates the buttock from the back of the thigh is more or less obliterated according to the degree of flexion at the hip-joint. The amount of fat, especially in the female, in this region, modifies very much the surface forms, so that the buttocks are more rounded in women than in men.

The muscles of the thigh are the sartorius and the extensor group in front, the three adductors and the gracilis internally, the tensor fasciæ on the outer side, and the three hamstring muscles behind.

The *tensor fasciæ muscle* (Plate 57) arises from the anterior and outer part of the crest of the ilium, and descends to be inserted into the *fascia lata* (page 105) about four inches below the great trochanter.

Action of the tensor fasciæ muscle.—It makes the fascia lata tense, thereby steadying the pelvis upon the femur.

The sartorius muscle (Plate 58, Fig. 2) is a very long, flat, ribbon-like band of parallel fibres arising from the top of the anterior superior spine of the ilium, and passes obliquely across the front of the thigh to the inner side, and then descends vertically as far as the knee where, behind the internal condyle of the femur, it becomes tendinous, and is inserted by a flat semi-lunar expansion into the inner and front part of the tibia below its tubercle (Plate 62, Fig. 2). The latter expansion covers the insertions of the tendons of the gracilis and semi-tendinosus muscles (Plate 58, Fig. 2).

Action of the sartorius muscle.—The action of the sartorius muscle is very complex. It assists in flexing and abducting the hip, at the same time rotating the leg inward, so that with the action of the gracilis and the semi-tendinosus the knee can be flexed. It serves also to steady the pelvis on the thigh. Acting from above, it first bends the leg upon the thigh and then the thigh upon the pelvis, and then rotates the thigh outward. Acting from the leg it bends the pelvis upon the thigh and then rotates it slightly inward. The muscle was called *sartorius* from the action of the two fellow muscles assisting in crossing the legs, as in the squatting position assumed by tailors when at their work. It is the longest muscle in the body, and being superficial through its entire length, produces a peculiar surface-marking in children before they have learned to stand or walk. This is indicated by a spiral crease across the middle of the thigh and is due to the habitual tendency to cross the legs at that period of life (Plate 121). In the well-developed adult the sartorius, when in action, presents a slightly curved elevation over its upper portion, while its lower portion produces a furrow, owing to the strap-like manner in which it compresses the adductor muscles. The sartorius should be carefully studied by sculptors, as a thorough understanding of it is essential in modeling the figure in action.

The entire shaft of the femur is covered by the *extensor muscles* (Plate 58, Fig. 2), the rectus, the vastus externus, the vastus internus, and the crureus. Collectively these four muscles form the *quadriceps extensor femoris.*

The rectus femoris muscle (Plate 57, Fig. 2) is interesting, as its structure affords an illustration of adaptation of great power within a short range of action. It arises by two portions—one, the reflected portion, from the upper margin of the acetabulum, and the other from the anterior inferior spine of the ilium. The two portions join at an acute angle about a hand's breadth below the groin. There is a median tendinous line from this point to the lower border of the sartorius, from which the fleshy fibres arise, descending in two lateral series diverging from each other, and produce a bi-penniform appearance (Plate 57, Fig. 2). The deep fibres descend vertically and are inserted into the united tendinous aponeurosis of the adjacent muscles about the patella.

Action of the rectus femoris muscle.—It serves, with its associate muscles, to extend the leg upon the thigh. When in action the rectus produces the anterior bulge on the surface of the thigh, and when the action is forcible its tendon produces a marked depression or flattening above the knee.

The vastus externus muscle (Plate 52, Fig. 1, and Plate 59, Fig. 2) arises from the base of the great trochanter, and from the outer border of the linea aspera. Its fibres descend to blend with the adjacent tendon of the rectus, and to be inserted into the outer border of the patella at its upper part.

The crureus muscle is practically a secondary portion of the vastus externus.

The vastus internus muscle (Plate 52, Fig. 1, and Plate 59, Fig. 2) is smaller than the externus, and arises by a tendon from the inner border of the linea aspera, and its fibres pass obliquely to be inserted into the adjacent borders of the crureus and rectus muscles and to the inner border of the patella as far as its lower border. It is consequently more fleshy lower down than any of the other muscles of the extensor group.

Action of the vastus internus muscle.—When this muscle is in action it produces the decided bulge above the knee at the inner side and lower part of the thigh.

The chief function of the quadriceps mass of extensor muscles is to extend the leg upon the thigh and thus straighten the lower limb, as in

walking or kicking. Acting from the leg, as in standing, the muscles serve to support the thigh upon the head of the tibia and thus maintain the entire weight of the body. It should be observed that the vasti and crureus are attached to the femur only, while the rectus is attached by its double origin to the pelvis, so that the latter either flexes the thigh or draws the pelvis forward.

The *adductor group of muscles* (Plate 58, Fig. 1) extend along the inner side of the thigh from the pelvis to the femur; they are the gracilis, the adductor longus, the pectinius, the adductor brevis, and the adductor magnus.

The gracilis muscle (Plate 57, Fig. 2) is the innermost muscle of the thigh and arises from the pubis and passes its tendons below the knee joint, behind the sartorius, and above the semi-tendinosus to be inserted on the front of the head of the tibia (Plate 58, Fig. 2). It is beneath the skin throughout the greater part of its course and produces the graceful outline of the inner side of the thigh.

Action of the gracilis muscle.—It coöperates with the semi-tendinosus in rotating the leg inward when the knee is about to be bent.

The adductor longus muscle (Plate 58, Fig. 1) arises from the pubis and expands to be inserted into the linea aspera.

The pectineus muscle (Plate 58, Fig. 1) is separated by a small space from the above muscle. It arises from the pubis and is inserted into the linea aspera near the root of the lesser trochanter.

The adductor brevis muscle (Plate 58, Fig. 1) arises from the pubis below the longus and pectineus muscles, and is inserted into the line between the linea aspera and the lesser trochanter.

The adductor magnus muscle (Plate 58, Fig. 1) arises mainly from the ischium and forms into a broad fleshy mass which is inserted into the whole length of the linea aspera and into the adductor tubercle of the internal condyle of the femur (Plate 59, Fig. 1).

Action of the adductor muscles of the thigh.—The combined action of the adductor group of muscles is chiefly in balancing the pelvis steadily on the thigh, as in standing on one leg, or in reversing that action to adduct the thighs,

at the same time causing them to rotate outwardly. In walking, they also assist in drawing forward the lower extremity. The special action of the two adductor magnus muscles serves in horseback riding to grip the saddle or the sides of the horse with the knees.

At the back of the thigh are the three flexor muscles, or *hamstring muscles.* They all arise from the tuberosity of the ischium (Plate 60, Fig. 1).

The biceps femoris muscle (Plate 60, Fig. 1) consists, as its name indicates, of two portions. The *long head* arises from the ischial tuberosity, in close connection with the semi-tendinosus, and at the lower part of the thigh the *short head* arises from the outer border of the linea aspera within an inch of the condyle. The fibres from these two heads form one common tendon, which is inserted into the upper and back part of the head of the fibula (Plate 60, Fig. 1).

Action of the biceps femoris muscle.—The biceps serves to flex the knee or to extend the hip. When the knee is bent it also causes the leg to rotate outward.

The semi-tendinosus muscle (Plate 60, Figs. 1 and 2) arises with the biceps and forms a fleshy mass, in the midst of which there is a tendinous intersection. It is inserted into the upper part of the inner surface of the tibia (Plate 60, Fig. 1).

The semi-membranosus muscle (Plate 60, Figs. 1 and 2, and Plate 62, Fig. 2) arises in the ischium by a flat tendon which descends nearly half way down the thigh beneath the other muscles, and ends in a large fleshy mass which is inserted into the inner and back part of the head of the tibia.

Action of the hamstring muscles.—These muscles serve to flex the leg upon the thigh. They are peculiar in being too short to allow of full flexion of the hip while the leg is extended. It should be noted that they possess the function of ligaments owing to their attachments passing over the two joints of the hip and the knee. When the pelvis is fixed, the thigh can only be moderately flexed while the knee is straight; but as soon as the knee is flexed the hamstrings are relaxed and the thigh can be entirely flexed From below their action is to support the pelvis and prevent the trunk from falling

forward. This is well shown in feats of strength where the body is thrown backward.

The tendons of the hamstring muscles form the boundaries of *the ham* or popliteal space at the back of the knee.

The skin over the thigh is coarse and thick on the outer and posterior surfaces, but fine and thin on the inner and anterior.

It should be understood that the *deep fascia of the thigh* is a very dense, strong membrane, which invests the muscles like a tightly-fitting sleeve, thereby maintaining them in position and augmenting their power. It is called the *fascia lata* (Plate 60, Fig. 2, and Plate 62, Fig. 1), and is strongest on the outer side, where the tendons of the glutens maximus and tenser femoris muscles are continued into it. This part of the fascia lata is called the *ilio-tibial band*, because it descends from the ilium to be inserted into the outer part of the head of the tibia. It is an important factor in maintaining the erect position.

On the front of the leg there are four muscles (Plates 64 and 67), the tibialis anticus, the extensor longus digitorum, the peroneus tertius and the extensor longus hallucis.

The tibialis anticus muscle (Plate 64, Fig. 1) arises from the head of the tibia and the upper part of the shaft and the adjacent part of the inter-osseous membrane. The fibres are aggregated into a long, flat tendon, which begins about the lower third of the leg and descends obliquely over the front of the ankle to the inner side of the foot (Plate 64, Fig. 2). It is attached to the internal cuneiform bone and the base of the meta-tarsal bone of the great toe.

Action of the tibialis anticus muscle.—It serves to flex the ankle and to turn the foot outward. When the foot is the fixed point, as in standing, it assists in balancing the body at the ankle.

The extensor longus digitorum muscle (the long extensor of the toes) (Plate 64, Fig. 3, and Plate 67, Fig. 2) arises from the outer part of the head of the tibia from the upper part of the tibia and inter-osseous membrane, and its fibres terminate in a penniform manner after a long tendon, which descends

in front of the ankle and divides into four slips, which pass over the dorsum of the foot and are inserted into the second and third phalanges of the four outer toes. Each of these tendons expands over the base of the corresponding first phalanx into a sheath above that joint and receives the tendon of the extensor brevis muscle.

The peroneus tertius muscle (Plate 67, Fig. 1) is really a portion of the preceding muscle. Its fibres arise from the lower part of the shaft of the fibula and the interosseous membrane, and its tendon is inserted into the dorsal surface of the base of the meta-tarsal bone of the little toe.

Action of the extensor longus digitorum and the peroneus tertius muscles. —The extensor longus digitorum, besides extending the toes, extends the ankle-joint. The peroneus tertius extends the foot and raises its outer border. The latter muscle, acting with the tibialis anticus, serves to raise the foot, and thus performs an important part in progression.

The extensor longus hallucis muscle (the long extensor of the great toe) (Plate 64, Fig. 2) arises from the inner border of the fibula and the interosseous membrane, and its tendon is inserted into the base of the second or ungual phalanx of the great toe (Plate 67, Fig. 3).

Action of the extensor longus hallucis muscle. — It serves to extend the great toe and, when in action, its tendon can be seen both at the dorsum of the foot and at the ankle.

The muscles on the outer side of the leg are the peroneus longus and the peroneus brevis.

The peroneus longus muscle (Plate 67, Fig. 1) is the most superficial. It arises from the outer surface of the fibula and its tendon descends behind the external malleatus over the outer side of the os calcis under the cuboid bone, whence it crosses the sole of the foot obliquely (Plate 68), to be inserted into the outer side of the base of the first phalanx of the great toe.

The peroneus brevis muscle (Plate 67, Fig. 1) arises from the lower part of the fibula, and its tendon passes also behind the external malleatus and separating from the tendon of the peroneus longus, is inserted at the back of the meta-tarsal bone of the little toe.

Action of the peroneus longus and brevis muscles.—The action of these muscles raises the outer border of the foot, so that the chief part of the

weight is thrown on to the ball of the great toe. Acting from the first, they also serve in balancing the body on one leg.

The muscles of the back of the leg are arranged in two layers. The superficial layer constitutes the *calf of the leg* and consists of the gastrocnemius, plantaris and soleus muscles.

The gastrocnemius (the double-bellied) muscle (Plate 65, Fig. 1) arises by two strong heads from the femur above the outer and inner condyles. The inner head is larger, longer and more muscular than the outer (Plate 65, Fig. 1), and they both broaden as they descend until they terminate below the middle of the leg in the *tendon of Achilles.*

The plantaris muscle (Plate 65, Fig. 2) is the analogue of a similar muscle which is especially developed in the bear. It is often wanting in man. It arises above the outer head of the gastrocnemius and terminates in a very long, delicate tendon, which descends between the gastrocnemius and the soleus muscles to the inner side of the tendon of Achilles, to be inserted at the inner part of the os calcis.

The soleus muscle (Plate 65, Fig. 2) is a broad, flat muscle, resembling the shape of a sole-fish. It arises from the head and upper part of the fibula and forms the oblique line of the tibia (Plate 63, Fig. 2). The fleshy portion of the soleus bulges laterally beyond the borders of the gastrocnemius and its tendinous expansion blends with the tendon of Achilles.

The tendon of Achilles is the strongest of all the tendons in the body. It is inserted into the back part of the os calcis, and measures about four and a half inches in length, and three-quarters of an inch in breadth, and one-quarter of an inch in thickness. The tendon expands somewhat at its insertion (Plate 65).

Action of the gastrocnemius and soleus muscles.—The muscles of the calf and their common tendon serve chiefly to raise the body on to the toes. The peculiar disposition of the two heads of the gastrocnemius and the attachment of the tendon of Achilles, by passing over the knee joint and the ankle joint, give the gastrocnemius the power of bending one of these joints while it flexes the other, as in walking. If acting from the heel, as in standing, the muscles assist in balancing the body by maintaining the leg perpendicularly upon the foot.

The *deep* layer of muscles of the back of the leg are the flexor longus digitorum, the flexor longus hallucis and the tibialis posticus.

The flexor longus digitorum muscle (the long flexor of the toes) (Plate 69, Fig. 1) arises from the tibia, and its fibres terminate in a tendon which passes behind the inner ankle to the sole of the foot and is inserted by four slips into the bases of the ungual phalanges of the four outer toes (Plate 68). In the sole of the foot, before it subdivides, the tendon receives the insertion of the flexor accessorius muscle. The digital tendons also pierce the corresponding tendons of the flexor brevis muscle before they pass to their insertions, the same way that the similar flexor tendons to the fingers are arranged in the hand.

The flexor longus hallucis muscle (the long flexor of the great toe) (Plate 65) arises from the lower part of the fibula and the interosseus membrane, and its tendon passes beneath the *sustentaculum tali* (Plate 68) to be inserted into the base of the ungual phalanx of the great toe.

Action of the flexor digitorum muscle.—The action of the long flexor muscle is to raise the body on the great toe, being especially concerned in walking and running.

The tibialis posticus muscle (Plate 67, Fig. 2) is very deeply situated beneath the preceding muscle. It arises from the shaft of the tibia and the interosseous membrane, and its tendon passes beneath that of the flexor longus digitorum (Plate 68) behind the internal malleolus, and crosses over the sole of the foot, to be inserted into the scaphoid and internal cuneiform bones.

Action of the tibialis posticus muscle.—It flexes and turns the foot inward.

The extensor brevis digitorum muscle (the short extensor of the toes) (Plate 65, Fig. 3) arises from the outer part of the os calcis and passes obliquely beneath the tendons of the extensor longus digitorum (page 105.) and terminates in four tendons, which are attached to the four inner toes.

There are four *dorsal interosseous muscles* (between the bones) in the foot (Plate 67, Fig. 3) which in their disposition and attachment closely resemble the similar muscles of the hand.

Action of the dorsal interosseous muscles.—These muscles tend to draw the toes away from the line of axis of the second toe.

There are three *plantar interosseous muscles* (Plate 69, Fig. 1) which also resemble their analogues in the hand.

Action of the plantar interosseous muscles.—They tend to draw the toes toward the line of axis of the second toe.

The two sets of interossei muscles chiefly produce flexion of the toes, although they also serve to draw the toes to or from one another, according to the side of the phalanges upon which they are inserted.

The *flexor brevis digitorum muscle* (the short flexor of the toes) (Plate 68) arises from the inner part of the os calcis, and passing forward, divides into four tendons, which pass to the four outer toes superficially to the tendons of the flexor longus muscle (page 105). At the bases of the first phalanges the tendons divide so as to allow the tendons of the flexor longus to pass between them, and then they again unite and are inserted into the second phalanges (Plate 68).

The flexor accessorius muscle (the accessory flexor) (Plate 68, Fig. 5) arises beneath the flexor brevis from the os calcis and is inserted into the tendon of the flexor longus before it subdivides, although its attachment is especially into that part of the flexor longus tendon which supplies the third and fourth toes.

Beneath the tendons of the flexor longus there are four tiny muscles called lumbricales (like earth worms).

Action of the flexor brevis digitorum muscle.—The flexor brevis digitorum flexes the second phalanges on the first phalanges and then flexes the latter on their meta-tarsal bones.

The flexor accessorius muscle serves to connect the obliquity of the main tendon of the flexor longus, which is due to the projection backward of the heel. The lumbricales act in the same way as their analogues in the hand (page 84).

The abductor hallucis muscle (the abductor of the great toe) (Plate 68, Fig. 2) arises from the inner part of the os calcis, and arching over the tendons which pass round the inner ankle, is inserted into the base of the first phalanx of the great toé and the inner sesamoid bone.

Action of the abductor hallucis muscle.—It flexes the first phalanx while it extends the second, although it is capable of abducting the great toe slightly inward from the middle line.

The flexor brevis hallucis muscle (the short flexor of the great toe) (Plate 68, Fig. 3) arises from the cuboid bone and divides into two portions, which

pass over the meta-tarsal bone of the great toe on each side of the tendon of the flexor longus hallucis, and they are inserted into the outer and inner sides of the second phalanx of the great toe and the corresponding sesamoid bones.

The sesamoid (seed-like) bones, in relation to their tendons, serve as a pulley through which the tendon of the flexor longus hallucis can act freely without being pressed upon, as in walking or running.

The adductor obliquus hallucis muscle (the oblique adductor of the great toe) (Plate 68, Fig. 2) is a strong little muscle arising from the second, third and fourth meta-tarsal bones and passes obliquely across the foot, to be inserted into the external sesamoid bone and the adjacent part of the second phalanx of the great toe.

The transversalis pedis muscle (the transverse muscle of the foot) (Plate 68, Fig. 3) arises by three slips from the fourth and fifth meta-tarso-phalangeal joints and passes transversely to be inserted into the other sesamoid bone with the above muscle.

The abductor minimi digiti muscle (the abductor of the little toe) (Plate 69, Fig. 3) is on the outer side of the foot, and arises from the os calcis and is inserted into the meta-tarsal bone and the third phalanx of the little toe.

The flexor brevis minimi digiti muscle (the short flexor of the little toe) arises from the meta-tarsal bone of the little toe and is inserted into the base of the third phalanx of the little toe.

The opponens minimi digiti muscle (the opposing muscle of the little toe) is part of the above muscle, and is inserted into the meta-tarsal bone of the little toe.

The plantar fascia (Plate 69, Fig. 3) is the strong condensation of the deep fascia which covers the tendons in the sole of the foot. It extends from the os calcis to the head of the meta-tarsal bones, and is well shown in Plate 69.

It assists materially in supporting the antero-posterior arch of the foot (page 96).

The annular ligaments at the ankle (Plate 67, Fig. 3) are condensations of the deep fascia, which serve to confine the tendons of the various muscles as they pass from the leg to the foot. Each tendon has a separate compartment as it passes through the annular ligament, and is also supplied with a synovial bursa to prevent friction.

The skin over the knee is very movable in front. It is dense in relation to the patella and the tubercle of the tibia, but at the sides and back of the joint it is thinner. The patella can always be readily felt through the integument, its inner border being more marked than its outer. When the lower limb is extended so that the leg is supported by the contraction of the quadriceps muscle, its tendons, the patella and the ligamentum patellæ are all in prominent relief, the patella being rigidly immovable against the lower end of the femur, but if the leg is supported in the same position so that the quadriceps is relaxed, the patella can be readily moved from side to side. In flexion the patella glides into the hollow between the condyles of the femur, so that in kneeling it is firmly fixed and receives the brunt of the pressure.

The skin over the leg is more closely connected with the deep fascia than it is over the thigh. Over the shin it is separated from the bone only by the subcutaneous fascia.

The skin in front of and behind the ankle and over the dorsal surface of the foot is thin and loose. On the sole of the foot the epidermis is remarkably dense and thick, especially over the heel and the outer border of the foot, and at the balls of the toes, which are the parts ordinarily subjected to pressure when the foot is in contact with the ground. Along the inner border of the foot and in the hollow of the arch of the foot the skin is more adherent and marked with wrinkles, which pass mostly toward the clefts between the three inner toes. Like the skin of the palm of the hand, the skin of the sole of the foot is generally adherent to the part which it covers.

PLATE 56.

Fig. 1. Drawing from a photograph of the front of the skeleton of the right hip, thigh and knee (with outline).

1. The crest of the ilium.
2. The anterior superior spinous process of the ilium.
3. The head of the femur.
4. The external trochanter of the femur.
5. The internal trochanter of the femur.
6. The shaft of the femur.
7. The external condyle of the femur.
8. The patella.
9. The head of the fibula.
10. The pubic bone.
11. The tuberosity of the ischium.
12. The adductor tubercle.
13. The head of the tibia.

Fig. 2. Drawing from a photograph of the back of the skeleton of the right hip, thigh and knee (with outline).

1. The sacrum.
2. The tuberosity of the ischium.
3. The adductor tubercle.
4. The internal condyle of the femur.
5. The upper end of the tibia.
6. The crest of the ilium.
7. The head of the femur.
8. The external trochanter of the femur.
9. The internal trochanter of the femur.
10. The linea aspera of the femur.
11. The external condyle of the femur.
12. The upper end of the fibula.


Fig. 1.
Fig. 2.

PLATE 57.

Fig. 1. Diagram showing the two vasti and obturator externus muscles in relation to the skeleton of the right hip, thigh and knee.

1. The greater trochanter of the femur.
2. The obturator externus muscle.
3. The lesser trochanter of the femur.
4. The vastus externus muscle.
5. The cut tendon of the rectus femoris muscles.
6. The external condyle of the femur.
7. The ligamentum patellæ.
8. The head of the fibula.
9. The spine of the pubis.
10. The ischium.
11. The space occupied by the adductor muscles.
12. The vastus internus muscle.
13. The internal condyle of the femur.
14. The superior articular surface of the tibia.
15. The tubercle of the tibia.

Fig. 2. Diagram showing the tensor vaginae femoris, the rectus femoris and the gracilis muscles in relation to the skeleton of the right hip, thigh and knee.

1. The anterior superior spinous process of the ilium.
2. The attachment of the rectus muscle to the anterior superior inferior spine of the ilium.
3. The tensor vaginæ fasciæ femoris muscle.
4. The reflected head of the rectus femoris muscle.
5. The position of the greater trochanter.
6. The fascia lata.
7. The rectus femoris muscle.
8. Space occupied by the vastus externus muscle.
9. The external condyle of the femur.
10. The ligamentum patellæ.
11. The head of the fibula.
12. The tubercle of the tibia.
13. The pubis.
14. The space occupied by the adductor muscles.
15. The gracilis muscle.
16. The space occupied by the vastus internus muscle.
17. The internal condyle of the femur.
18. The attachment of the tendon of the gracilis muscle on the head of the tibia.

PLATE 58.

Fig. 1. Diagram showing the gluteus minimis and adductor muscles of the right thigh in relation to the skeleton.

1. The gluteus minimus muscle.
2. The lesser trochanter of the femur.
3. The pectineus muscle.
4. The adductor brevis muscle.
5. The adductor longus muscle.
6. The adductor magnus muscle.
7. The space occupied by the vastus externus muscle.
8. The femoral arch.
9. The pubis.
10. The space occupied by the gracilis muscle.
11. The adductor tubercle.

Fig. 2. Diagram showing all the muscles of the right thigh in relation to the skeleton (*from the front*).

1. The external oblique muscle of the abdomen.
2. The anterior superior spinous process of the ilium.
3. The gluteus maximus muscle.
4. The tensor vaginæ femoris muscle.

Fig. 2.—continued.

5. The position of the lesser trochanter of the femur.
6. The pectineus muscle.
7. The adductor longus muscle.
8. The vastus externus muscle.
9. The fascia lata.
10. The rectus femoris muscle.
11. The ligamentum patellæ.
12. The attachment of the vastus externus muscle at the top of the patella.
13. The ligament of Poupart.
14. The spermatic cord.
15. The gracilis muscle.
16. The sartorius muscle.
17. The adductor magnus muscle.
18. The vastus internus muscle.
19. The tendon of the sartorius muscle.
20. The attachment of the vastus internus muscle at the side of the patella.
21. The tendon of the sartorius muscle.
22. The tendon of the gracilis muscle.
23. The tendon of the semi-tendinosus muscle.

PLATE 59.

Fig. 1. Diagram showing the external rotator muscles of the hip, and the great adductor muscle of the thigh in relation to the skeleton (*from the back*).

1. The coccyx.
2. The adductor magnus muscle.
3. The adductor tubercle of the femur.
4. The gluteus minimus muscle.
5. The pyriformis muscle.
6. The gemellus superior muscle.
7. The obturator internus muscle.
8. The greater trochanter of the femur.
9. The quadratus femoris muscle.
10. The upper portion of the adductor magnus muscle.
11. The space occupied by the vastus externus muscle.

Fig. 2. Diagram showing the gluteus medius muscle and the attachments of the two vasti muscles on the back of the right thigh.

1. The ischium.
2. The lesser trochanter of the femur.
3. The space occupied by the adductor and hamstring muscles.
4. The linea-aspera of the femur.
5. The vastus internus muscle.
6. The gluteus medius muscle.
7. The gemellus superior muscle.
8. The greater trochanter of the femur.
9. The vastus externus muscle.

PLATE 59

PLATE 60.

Fig. 1. Diagram showing the hamstring muscles and tendons on the back of the right thigh and knee.

1. The tuberosity of the ischium.
2. The adductor magnus muscle.
3. The semi-tendinous muscle.
4. The biceps femoris muscle.
5. The gracilis muscle.
6. The semi-membranous muscle.
7. The vastus internus muscle.
8. The tendon of the gracilis muscle.
9. The tendon of the semi-membranosus muscle.
10. The tendon of the semi-tendinosus muscle.
11. The space occupied by the glutei muscles.
12. The space occupied by the vastus externus muscle.
13. The short head of the biceps femoris muscle.
14. The lower portion of the semi-membranosus muscle.
15. The tendon of the biceps muscle at the head of the fibula.

Fig. 2. Diagram showing all the muscles of the right hip and thigh (*from the back*).

1. The gluteus maximus muscle.
2. The gracilis muscle.
3. The semi-tendinosus muscle.
4. The semi-membranosus muscle.
5. The biceps femoris muscle.
6. The vastus internus muscle.
7. The tendon of the semi-tendinosus muscle.
8. The tendon of the semi-membranosus muscle.
9. The tendon of the gracilis muscle.
10. The tendon of the sartorius muscle.
11. The head of the tibia.
12. The gluteus medius muscle.
13. The greater trochanter of the femur.
14. The fascia lata.
15. The adductor magnus muscle.
16. The vastus externus muscle.
17. The short head of the biceps femoris muscle.
18. The lower portion of the semi-membranosus muscle.
19. The head of the tibia.

Fig. 1.

Fig. 2.

PLATE 61.

Drawings from photographs of the outside and inside of the skeleton of the right hip, thigh and knee (with outlines).

Fig. 1.

1. The crest of the ilium.
2. The posterior inferior spinous process of the ilium.
3. The acetabulum.
4. The coccyx.
5. The tuberosity of the ischium.
6. The shaft of the femur.
7. The external condyle of the femur.
8. The head of the fibula.
9. The anterior superior process of the ilium.
10. The anterior inferior spinous process of the ilium.
11. The head of the femur.
12. The external trochanter of the femur.
13. The patella.
14. The head of the tibia.

Fig. 2.

1. The anterior superior spinous process of the ilium.
2. The promontory of the sacrum.
3. The pubic bone.
4. The tuberosity of the ischium.
5. The shaft of the femur.
6. The patella.
7. The head of the tibia.
8. The position of the head of the femur.
9. The coccyx.
10. The lesser trochanter of the femur.
11. The internal condyle of the femur.
12. The head of the fibula.


10
13
14

PLATE 62.

Fig. 1. Diagram of all the muscles on the outer side of the right thigh.

1. The crest of the ilium.
2. The gluteus maximus muscle.
3. Position of the great sciatic notch.
4. The position of the coccyx.
5. The gluteus maximus muscle.
6. The fascia lata.
7. The semi-membranosus muscle.
8. The biceps muscle.
9. The biceps muscle.
10. The expansion of the fascia lata at the knee.
11. The outer head of the gastrocnemius muscle.
12. The attachment of the biceps muscle on the head of the fibula.
13. The calf of the leg.
14. The gluteus medius muscle.
15. The tensor vaginæ femoris muscle.
16. The sartorius muscle.
17. The rectus femoris muscle.
18. The vastus externus muscle.
19. The patella.
20. The head of the tibia.

Fig. 2. Diagram of all the muscles on the inner side of the right thigh.

1. The anterior superior spinous process of the ilium.
2. The iliacus muscle.
3. The pectineal line.
4. The inner wall of the pelvis.
5. The adductor longus muscle.
6. The gracilis muscle.
7. The sartorius muscle.
8. The rectus femoris.
9. The vastus internus muscle.
10. The patella.
11. The tendon of the sartorius muscle.
12. The promontory of the sacrum.
13. The pyriformis muscle.
14. The tip of the coccyx.
15. The gluteus maximus muscle.
16. The semi-membranosus muscle.
17. The semi-tendinosus muscle.
18. The tendon of the gracilis muscle.
19. The tendon of the semi-tendinosus muscle.
20. The tendon of the semi-membranosus muscle.

PLATE 62

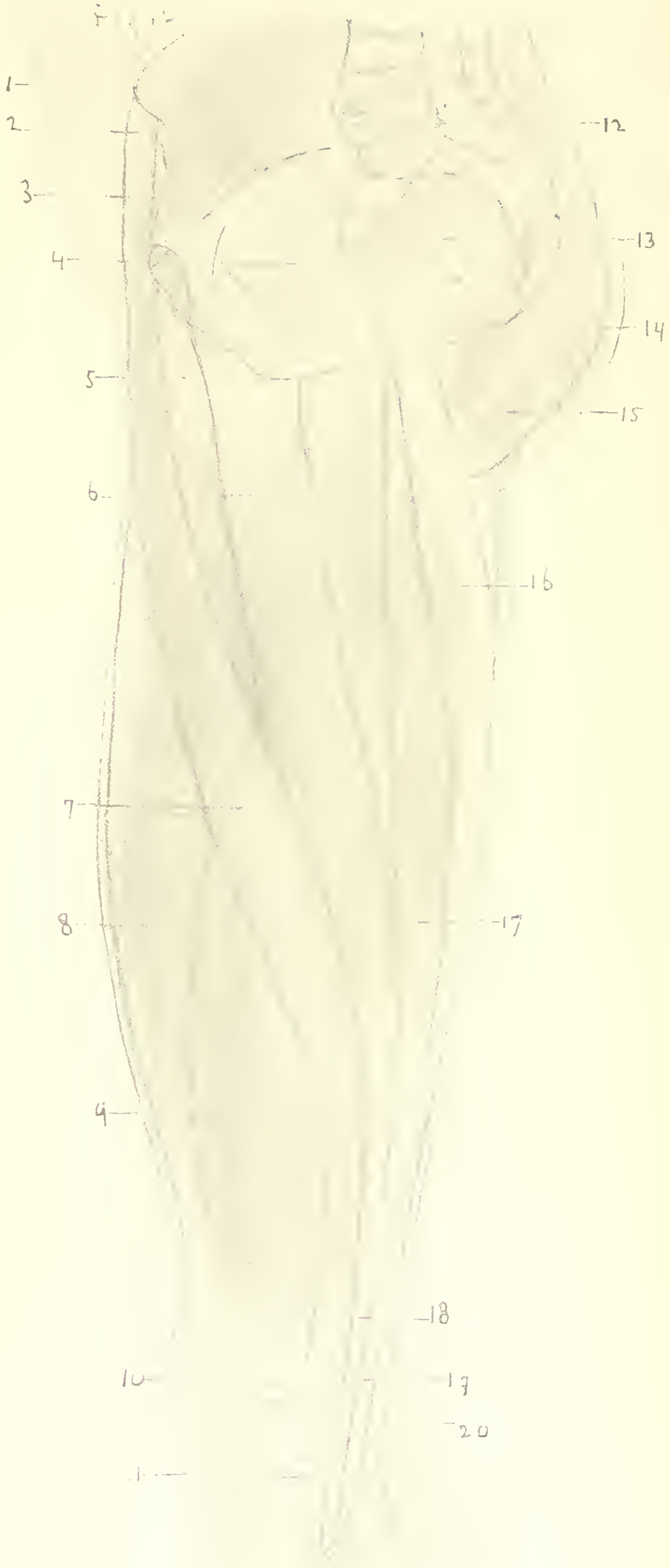


PLATE 63.

Fig. 1. Drawing from a photograph of the skeleton of the right knee, leg and foot (*from the front*).

1. The external condyle of the femur.
2. The patella.
3. The head of the fibula.
4. The shaft of the fibula.
5. The external malleolus.
6. The cuboid bone.
7. The tuberosity of the meta-tarsal bone of the little toe.
8. The adductor tubercle of the femur.
9. The tubercle of the tibia.
10. The crest of the shaft of the tibia.
11. The internal malleolus.
12. The astragalus.
13. The scaphoid bone.
14. The internal cuneiform bone.
15. The head of the meta-tarsal bone of the great toe.
16. The first phalanx of the great toe.
17. The ungual phalanx of the great toe.

Fig. 2. Drawing from a photograph of the skeleton of the right knee, leg and foot (*from the back*).

1. The adductor tubercle of the femur.
2. The oblique line of the tibia.
3. The shaft of the tibia.
4. The internal malleolus.
5. The os calcis.
6. The external condyle of the femur.
7. The head of the tibia.
8. The head of the fibula.
9. The shaft of the fibula.
10. The external malleolus.
11. The cuboid bone.
12. The meta-tarsal bone of the little toe.

Fig. 1.

Fig. 2

PLATE 64.

Diagrams of the muscles in relation to the bones of the right leg (*from the front*).

Fig. 1. The attachments of the anterior tibial muscle.

1. The head of the tibia.
2. The tibialis anticus muscle.
3. The space occupied by the peronei muscles.
4. The external malleolus.
5. The tubercle of the tibia.
6. The position of the gastrocnemius muscle.
7. The position of the soleus muscle.
8. The position of the flexor longus digitorum muscle.
9. The internal malleolus.
10. The insertion of the tendon of the tibialis anticus.

Fig. 2. The attachments of the chief extensor muscle of the great toe.

1. The head of the fibula.
2. The extensor proprius pollicis muscle.
3. The external malleolus.

Fig. 2.—continued.

4. The tubercle of the tibia.
5. The crest of the tibia.
6. The internal malleolus.
7. The tendon of the extensor proprius pollicis muscle passing over the ankle.
8. The insertion of the tendon of the extensor proprius pollicis muscle.

Fig. 3. The attachments of the long extensor muscle of the toes.

1. The head of the fibula.
2. The extensor longus digitorum muscle.
3. The external malleolus.
4. The long tendons passing to the several toes.
5. The crest of the tibia.
6. The internal malleolus.

PLATE 64

Fig. 1.

Fig. 2.

Fig. 3

PLATE 65.

Diagrams of the muscles in relation to the bones of right leg (*from the back*).

Fig. 1. The attachments of the superficial muscles of the calf of the right leg.

1. The adductor tubercle on the internal condyle of the femur.
2. The inner portion of the gastrocnemius muscle.
3. The internal malleolus of the tibia.
4. The tendo Achillis.
5. The external condyle of the femur.
6. The outer portion of the gastrocnemius muscle.
7. The external malleolus of the fibula.

Fig. 2. The attachments of the deeper muscles of the calf of the right leg.

1. The internal condyle of the femur.
2. The tendon of the plantaris muscle.
3. The internal malleolus of the tibia.
4. The tendon of the plantaris muscle.
5. The cut tendon of the gastrocnemius muscle.

Fig. 2.—continued.

6. The plantaris muscle.
7. The head of the fibula.
8. The soleus muscle.
9. The external malleolus of the fibula.

Fig. 3. The attachments of the deeper muscles of the right leg.

1. The popliteus muscle.
2. The flexor longus pollicis muscle.
3. The tendon of the flexor longus pollicis muscle.
4. The internal malleolus of the tibia.
5. The external condyle of the femur.
6. The head of the fibula.
7. The external malleolus of the fibula.
8. The tendon of the peroneus longus muscle.

PLATE 65

Fig. 1.

Fig. 2

Fig. 3.

PLATE 66.

Drawings from photographs.

Fig. 1. The skeleton of the right knee, leg and foot, with outline (*from the outer side*).

1. The internal condyle of the femur.
2. The head of the fibula.
3. The shaft of the fibula.
4. The external malleolus.
5. The os calcis.
6. The patella.
7. The head of the tibia.
8. The tubercle of the tibia.
9. The shaft of the tibia.
10. The lower end of the tibia.
11. The astragalus.
12. The scaphoid bone.
13. The middle cuneiform bone.
14. The outer cuneiform bone.
15. The meta-tarsal bone of the second toe.

Fig. 2. The skeleton of the right knee, leg and foot, with outline (*from the inner side*).

1. The patella.
2. The tubercle of the tibia.
3. The shaft of the tibia.
4. The lower end of the tibia.

Fig. 2.—continued.

5. The scaphoid bone.
6. The middle cuneiform bone.
7. The inner cuneiform bone.
8. The meta-tarsal bone of the great toe.
9. The proximal phalanx of the great toe.
10. The internal condyle of the femur.
11. The head of the fibula.
12. The shaft of the fibula.
13. The astragalus.
14. The os calcis.

Fig. 3. The skeleton of the right ankle and foot, with outline (*from above*).

1. The external malleolus.
2. The os calcis.
3. The cuboid bone.
4. The styloid process of the meta-tarsal bone of the little toe.
5. The internal malleolus.
6. The astragalus.
7. The scaphoid bone.
8. The outer cuneiform bone.
9. The middle cuneiform bone.
10. The inner cuneiform bone.

PLATE 66

PLATE 67.

Fig. 1. Diagram of the muscles and tendons on the outside of the right leg and ankle.

1. The plantaris muscle.
2. The outer portion of the gastrocnemius muscle.
3. The peroneus longus muscle.
4. The gastrocnemius muscle.
5. The peroneus brevis muscle.
6. The peroneus longus muscle.
7. The tendo Achillis.
8. The external malleolus.
9. The tendon of the peroneus longus muscle.
10. The tendon of the peroneus brevis muscle.
11. The patella.
12. The ligamentum patellæ.
13. The extensor longus digitorum muscle.
14. The tibialis anticus muscle.
15. The tendons of the extensor longus digitorum muscle.
16. The tendons of the peroneus tertius.

Fig. 2. Diagram of the muscles and tendons on the inner side of the right leg and ankle.

1. The patella.
2. The ligamentum patellæ.
3. The tibialis anticus muscle.
4. The crest of the tibia.
5. The tendon of the tibialis anticus muscle.
6. The position of the head of the fibula.
7. The gastrocnemius muscle.
8. The soleus muscle.
9. The flexor longus digitorum muscle.

Fig. 2—continued.

10. The tendo Achillis.
11. The tendon of the plantaris muscle.
12. The internal malleolus.
13. The tendon of the flexor longus pollicis muscle.
14. The tendon of the tibialis posticus muscle.
15. The tendon of the flexor longus digitorum muscle.

Fig. 3. The tendons on the front of the right ankle and foot.

1. The extensor longus digitorum muscle.
2. The upper portion of the annular ligament.
3. The tendons of the extensor longus digitorum muscle.
4. The lower portion of the annular ligament.
5. The dorsal interosseous muscle to the fourth toe.
6. The tendon of the dorsal interosseous muscle to the third toe.
7. The tendon of the dorsal interosseous muscle on the fibular side of the second toe.
8. The flexor longus digitorum muscle.
9. The tendon of the extensor proprius pollicis muscle.
10. The tendon of the tibialis anticus muscle.
11. The tendon of the dorsal interosseous muscle on the tibial side of the second toe.
12. The tendon of the extensor proprius pollicis muscle.

PLATE 67

PLATE 68.

Fig. 1. The plantar surface of the skeleton of the right foot, with outline (from a photograph).

1. The meta-tarsal bone of the little toe.
2. The meta-tarsal bone of the fourth toe.
3. The styloid process of the meta-tarsal bone of the little toe.
4. The cuboid bone.
5. The os calcis.
6. The ungual phalanx of the great toe.
7. The first phalanx of the great toe.
8. The sesamoid bones.
9. The meta-tarsal bone of the second toe.
10. The meta-tarsal bone of the great toe.
11. The meta-tarsal bone of the middle toe.
12. The internal cuneiform bone.
13. The external cuneiform bone.
14. The scaphoid bone.
15. The astragalus.
16. The sustentaculum tali of the os calcis.

Fig. 2. The abductor and adductor muscles of the great toe.

1. The adductor pollicis pedis muscle.
2. The styloid process of the meta-tarsal bone of the little toe.
3. The os calcis.
4. The tendon of the abductor pollicis pedis muscle.
5. The tendon of the adductor pollicis pedis muscle.
6. The abductor pollicis pedis muscle.
7. The position of the sustentaculum tali of the os calcis.

Fig. 3. The short flexor muscles of the great and little toes.

1. The transversus pedis muscle.
2. The flexor brevis minimi digiti muscle.
3. The styloid process of the meta-tarsal bone of the little toe.
4. The os calcis.
5. The tendon of the flexor brevis pollicis muscle.
6. The flexor brevis pollicis muscle.
7. The position of the external cuneiform bone.
8. The scaphoid bone.

Fig. 4. The relations of the principal flexor tendons in the sole of the right foot.

1. The styloid process of the meta-tarsal bone of the little toe.
2. The tendon of the peroneus longus muscle.
3. The os calcis.
4. The tendon of the flexor longus pollicis muscle between the sesamoid bones.
5. The tendon of the peroneus longus muscle.
6. The internal cuneiform bone.
7. The tendon of the flexor longus digitorum muscle.
8. The scaphoid bone.
9. The astragalus.
10. The tendon of the flexor longus digitorum muscle.
11. The tendon of the flexor longus pollicis muscle.

Fig. 5. The accessory flexor and lumbrical muscles in the sole of the right foot.

1. The lumbrical muscle of the little toe.
2. The lumbrical muscle of the fourth toe.
3. The styloid process of the meta-tarsal bone of the little toe.
4. The outer origin of the flexor accessorius muscle.
5. The lumbrical muscle of the middle toe.
6. The lumbrical muscle of the second toe.
7. The tendon of the flexor longus digitorum muscle.
8. The scaphoid bone.
9. The tendon of the flexor longus digitorum muscle.
10. The inner origin of the flexor accessorius muscle.

Fig. 6. The short flexor muscle of the toes.

1. The short flexor tendon of the little toe.
2. The short flexor tendon of the fourth toe
3. The styloid process of the meta-tarsal bone of the little toe.
4. The short flexor tendon of the second toe.
5. The short flexor tendon of the middle toe.
6. The flexor brevis digitorum muscle.

PLATE 68

PLATE 69.

Fig. 1. The abductor muscle of the little toe, and the three plantar interossei muscles of the right foot.

1. The interosseous muscle to the little toe.
2. The interosseous muscle to the fourth toe.
3. The interosseous muscle to the middle toe.
4. The abductor minimi digiti pedis muscle.

Fig. 2. Superficial view of all the muscles of the sole of the right foot complete.

1. The lumbrical muscle and flexor tendon to the little toe.
2. The lumbrical muscle and flexor tendon to the second toe.
3. The flexor brevis minimi digiti muscle.
4. The flexor brevis digitorum muscle.
5. The abductor minimi digiti muscle.
6. The lumbrical muscle and flexor tendon to the middle toe.
7. The tendon of the flexor longus pollicis pedis muscle.
8. The flexor brevis pollicis muscle.
9. The abductor pollicis pedis muscle.
10. The cut end of the plantar fascia.

Fig. 3. The plantar fascia.

1. Transverse slips of the plantar fascia passing over the bases of the toes.
2. The plantar fascia dividing over the meta-tarso phalangeal joints.
3. The plantar fascia.
4. Deep fascia ensheathing the muscles of the outside of the foot.
5. The attachment of the plantar fascia to the os calcis.
6. Slip of the plantar fascia passing to the base of the great toe.
7. Deep fascia ensheathing the muscles on the inside of the foot.

Fig. 4. The dorsal surface of the skeleton of the right foot, with outline from a photograph).

1. The ungual phalanx of the great toe.
2. The first phalanx of the great toe.
3. The meta-tarsal bone of the great toe.
4. The internal cuneiform bone.
5. The middle cuneiform bone.
6. The scaphoid bone.

Fig. 4—continued.

7. The astragalus.
8. The os calcis.
9. The meta-tarsal bone of the fourth toe.
10. The meta-tarsal bone of the little toe.
11. The meta-tarsal bone of the middle toe.
12. The meta-tarsal bone of the second toe.
13. The external cuneiform bone.
14. The styloid process of the meta-tarsal bone of the little toe.
15. The cuboid bone.
16. The posterior portion of the os calcis.

Fig. 5. The four dorsal interossei muscles of the right foot.

1. The first phalanx of the great toe.
2. The dorsal interosseous muscle on the tibial side of the second toe.
3. The internal cuneiform bone.
4. The astragalus.
5. The os calcis.
6. The dorsal interosseous muscle on the fibular side of the second toe.
7. The dorsal interosseous muscle on the fibular side of the middle toe.
8. The dorsal interosseous muscle on the fibular side of the fourth toe.
9. The external cuneiform bone.
10. The cuboid bone.
11. The os calcis.

Fig. 6. The extensor brevis digitorum muscle of the right foot.

1. The short extensor tendon to the great toe.
2. The short extensor tendon to the second toe.
3. The cut tendon of the extensor longus pollicis muscle.
4. The internal cuneiform bone.
5. The scaphoid bone.
6. The short extensor tendon to the fourth toe.
7. The short extensor tendon to the middle toe.
8. The extensor brevis digitorum pedis muscle.
9. The os calcis.

PLATE 69

PLATE 70.

Photograph of a woman's foot in various positions.

Fig. 1. The right foot with the heel raised and the weight received on the balls of the toes (*from the inner side*).

Fig. 2. The left foot resting firmly on the ground (*from the front*).

Fig. 3. The left foot with the heel slightly raised and the weight lightly received on the toes (*from the back*).

Fig. 4. The right foot with the heel raised and the weight received on the balls of the toes (*from the back*).

Fig. 5. The right foot with the heel raised and the weight received on the toes as in walking.

Fig. 6. The left foot pointing as in stepping forward.

Fig. 7. The left foot with the heel raised and the weight received on the toes as in walking.

Fig. 8. The right foot pendant (*from the inner side*).

Fig. 9. The left foot pendant (*from the outer side*).

N. B.—Figs. 1, 2, 3 and 4 show positions of the feet as in dancing.

PLATE 70

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 7

Fig. 8

Fig. 9

GENERAL CONSIDERATION OF THE ENTIRE SKELETON.

THE height, breadth and depth of the outward form of a man or woman depend upon the general character and proportion of the bony framework of the body. (Plates 2, 4 and 6.)

From the skull to the bones of the feet the human skeleton is constructed for the erect position. The upper limbs are specially attached to the trunk by the shoulder girdle (page 70), which is *incomplete* behind so as to allow freedom for the purposes of tact and prehension, while the lower limbs are received at the pelvic girdle (page 89), which is *complete*, so as to enable them to support the trunk. It should be observed that the separate parts of both the upper and lower limbs, the arm, forearm and hand in the one, and the thigh, leg and foot in the other, diminish in length in regular order from the trunk to the fingers and toes.

The thorax (page 51) is wider transversely than it is deep, which allows the weight of the trunk to be distributed to the two lower limbs to advantage when in the erect position.

The vertebral column (page 49) presents compensating curvatures which admit of elasticity and insure security in the various movements; and the pelvis (page 89) is broad and strong, serving as a basis for the whole trunk in whatever direction the weight be transmitted.

The upper limbs (page 69) are not as long as the lower. Besides the incompleteness of the shoulder girdle, the facts that the upper limbs are only connected by the collar bones to the sternum, and that the shoulder joint is capable of a range of motion in all directions, indicate that they are not designed for support. The inter-dependence of the shoulder, elbow and wrist joints, and the peculiar arrangement of the movable bone of the forearm (the radius) which enables the hand to be pronated or supinated, adapt the upper limb to reach any part of the body. The joints of the upper limb all bend in the same direction. The wrist is in a line with the forearm, and the bones

of the fingers and thumb are specially arranged for opposing one another, useful for the most delicate sense of touch as well as for grasping objects strongly.

The lower limbs (page 91) are longer than the upper. The thighs and legs are long in proportion to the body. The joints are adapted so that they bend in opposite directions alternately, as is necessary for progression. The feet are relatively large and at right angles to the legs, so that they can be placed on the ground in order to receive the weight of the body. The great toe is not opposable to the other toes as for purposes of grasping, but is characteristically large and strong to assist in steadying the weight.

Although it is true that much of the difference between the male and the female forms depend upon the differences in the skeletons, yet it requires the trained eye of an anatomist to distinguish them.

The height of the female skeleton is less than that of the male, as a rule. There is less difference to be found in the length of the trunk than there is in the lower limbs. The illustrations (Plates 2, 4 and 6) show this better than can be impressed by any description. Generally speaking, every bone in the female skeleton is shorter, more slender, smoother and weaker than the corresponding bone in the male. The bones in the male skeleton are usually rougher and stronger.

PLATE 71.

This figure represents the skeleton of a man in the sitting posture, the body resting upon both ischial tuberosities. The head is raised and turned toward the left shoulder, while the right fore-arm is resting on the left knee which is crossed over the right. The right hand is outstretched. The whole suggesting an ordinary position assumed by one who is engaged in argument.

The line of gravity passes from the neck in the direction indicated by the arrow-head. The position of the right foot and of the left arm assist the figure to retain its poise on the bench. If they were changed, the figure could not remain seated without moving further back, thereby bringing the right knee in a line perpendicular to the right heel.

This plate also shows the curvatures of the spinal column as they would be influenced by assuming this position.

N. B.—This figure is modified from a plate by Martinez, first published in 1660. (See page 118.)

PLATE 71

PLATE 72.

Fig. 1. Back view of the skeleton of a man in the standing position, with the right arm extended as by a gesture of inquiry, and the left hand is resting on the handle of a pickax, the head of which is on the ground so that it assists the muscular action in supporting the weight of the body. The attitude and surface form indicate a man of advancing years, well developed and accustomed to hard labor.

Fig. 2. Represents the skeleton of a woman in the sitting position with both arms raised as in exclamatory action. It illustrates the curvatures in the neck and loins peculiar to woman, and the contrast between the surface form of the female figure in this position and that of the male form, as in Fig. 1, is well shown by the outlines.

N. B.—These figures are also modified from a plate by Martinez, first published in 1660. (See page 118.)

PLATE 72

fig. 1

fig. 2

PLATE 73.

Fig. 1. Drawing from a photograph of a man running.

Fig. 2. Drawing of the skeleton in its relation to the surface form, in the same position as in Fig. 1.

N. B.—The camera caught the man's picture while he was entirely off the ground, and at the moment when both the upper and lower limbs were fully extended. It will be noticed that the arm is thrown forward on the side on which the leg is thrown backward, and that on the side on which the arm is thrown backward the leg is advanced, thus assisting to maintain the balance.

PLATE 73

fig. 1

fig. 2

THE INFLUENCE OF THE SKELETON ON THE SURFACE FORM.

THE shape and character of the features and of the head, and especially the traits of family and of race, depend in a great measure upon the conformation of the cranium and of the bones of the face. No two skulls are ever exactly alike. The variations of form of the living head are dependent upon degrees of development in size and shape of the bones which give origin to the individual features. There are certain types noticeable in families which underlie these individual distinctions and should be observed by artists as characteristic of the bones and usually indicative of race.

The special influence exerted upon the surface by the several bones of the skull is particularly described in the text relating to these bones.

The curves of the human back are due to the curvatures of the vertebral column, as will be best appreciated by comparing the back of a model with that of a skeleton in different positions (Plates 72, 77, 86 and 92).

The only parts of the vertebral column which are subcutaneous are the spinous processes, and these occupy the longitudinal furrow caused by the lateral bulging of the masses of erector muscles. Of the spinous processes that of the seventh cervical vertebra is most conspicuous.

The surface forms dependent upon the component bones of the thorax are chiefly noticeable at the sides of the chest, where the ribs form oblique elevations extending downward from the axillæ, or arm-pits. Also, the outlines of the ribs can be distinguished in front, especially below the borders of the great pectoral muscles. In forced expiration and in certain positions of the body, especially when supporting a weight from above (Plate 42), the curved arch formed by the costal cartilages is more or less seen. The arch is wider in short individuals than in tall ones, and in general conformation the bony

cage corresponds to the stature of the person possessing it, the capacity of the chest-wall varying with the degree of expansion or contraction during respiration.

The junction of the first and second bones of the sternum is indicated by a ridge on the surface, as at this joint the cartilages of the second ribs are attached (page 51), and it is possible to determine through the skin the third, fourth and fifth ribs by counting down from this ridge in numerical order.

The different planes of the three portions of the sternum naturally influence the outline of the chest as seen in profile (Plates 24 and 38). When the pectoral muscles are well developed the sternum occupies a median furrow which is wider above and below and narrower in the middle.

The mobility of the shoulder girdle produces many subtle changes of surface forms, which are difficult to define, notwithstanding that the main portions of the clavicles and scapulæ are subcutaneous.

The shaft of the humerus, or arm-bone, mainly affects the outer surface by influencing the shape of the muscles attached to it, as it is covered by muscles on all sides.

At the elbow, the prominences of the condyles of the humerus and the upper end of the ulna are almost as conspicuous on the surface as they are in the skeleton. They are deserving of close attention and should be examined with the joint in every degree of flexion and extension, so as to appreciate the changes of relation which the prominences bear to one another in each position. The point of the elbow is formed by the olecranon process of the ulna in all positions.

The two bones of the fore-arm, the radius and the ulna, being generally parallel, give a flattened form to this part of the limb. The upper portions of these bones, excepting at the point of the elbow, are covered by the muscles. The styloid processes of the lower ends of the radius and ulna are subcutaneous; that of the ulna is more prominent in pronation.

The bones of the hand influence the outer surface chiefly from their dorsal aspect. The elevation of the knuckle-joint of the middle finger is greater than that of the others, and gives character in delineating the first. The shape of the thumb is dependent upon the articulation of its first phalanx with the trapezium, and it is rarely the same in any two persons. It is for this reason that the angle at which the thumb is extended from the outspread hand differs so widely in individuals. Every artist should pay particular attention to the size and shape of the thumb, as it contributes more than any other feature to the character of the hand.

The pelvis only influences the surface in a remote way, and the parts which are most conspicuous are the crest and the spines of the ilia. The pelvic girdle being complete furnishes an important factor in judging of the relations of the prominences on the two sides of the pelvis, because they always retain their relations in all positions of the body, vertical, horizontal or inclined. When a man is standing with both feet on a level surface, the corresponding spinous processes of the pelvis must be in a horizontal line. Any inclination of one spinous process, as in standing on one leg, must result in a corresponding degree of elevation of the other.

The sculptor should understand this, and bear in mind that the pelvis moves on the thighs as a whole solid mass under all circumstances.

The shaft of the femur, or thigh bone, like the humerus is covered everywhere by the muscles and imparts its anterior curved form to the thigh, thereby giving the effect of strength to the whole limb. The lower end of the femur is broadened just above the knee and gives the flattened appearance at this locality. When standing with the thigh rotated outward there is a depression over the great trochanter; when the legs are crossed, this depression becomes an eminence.

At the knee, the lower end of the femur contributes greatly to the surface form. The condyles are always prominent, especially the internal condyle, although it is more thickly covered than the outer. The patella, or knee-pan, is always marked, appearing as a triangular prominence.

The two bones of the leg, the tibia and the fibula, are always in the same relation to one another, and the crest of the tibia (shin-bone) offers a greater extent of subcutaneous surface than any other bone in the skeleton. The fibula is always at the outer and back part of the leg. At the ankle, the lateral projections of the tibia and fibula, called malleoli, are always prominent. The outer malleolus, belonging to the fibula, is considerably lower and less prominent than the inner malleolus belonging to the tibia (Plates 55 and 56).

The bones of the foot, like those of the hand, chiefly influence the upper surface. The arch of the instep is due to the shape of the bones forming it. The posterior prominence of the heel-bone, the os calcis, is also conspicuous and gives character to the back of the foot. The great toe is always a distinguishing feature. Much stress has been usually laid on the second toe being longer than the others in the well-formed foot. It is more frequently so in tall and slim persons. It is generally equal in length to the great toe.

The figures on Plates 71 and 72 were drawn, in 1660, by a Spanish artist named Chrysostom Martinez. They were republished, with slight modifications, by J. Rubens Smith, of Boston, in 1827. They have been redrawn by the author, with corrections as to the character of the bones, and adapted by him in preference to introducing original drawings of the same nature which he had intended. They serve the double purpose of being artistically of value as elucidating the influence of motion on external form, and of showing that the same idea of illustrative teaching was entertained as long as two hundred and forty years ago. The fore-shortening and proportions of the figures are certainly admirable.

PLATE 74.

Photograph of a woman's skeleton, in the sitting posture, by the side of a spinning-wheel, with the left foot resting upon a stool and the right foot on the treadle of the wheel. The hands are raised as in separating the threads of flax so as to pass them round the wheel. This plate is to be compared with Plate 75.

PLATE 75.

Photograph of a woman spinning, to be compared with the photograph of the skeleton in the same position, shown in Plate 74.

PLATE 74

PLATE 75

PLATE 76.

Fig. 1. Photograph of a woman's skeleton standing with the right arm raised to support a jar as if resting on the head (*from the front*).

Fig. 2. Photograph of a woman in the same position as the skeleton in Fig. 1.

Fig. 3. Photograph of the same woman in the same position as in Fig. 2 (with drapery).

N. B.—These figures, as well as those on Plate 77, afford an opportunity of comparing the relation of the skeleton to the surface form, and the effect of the surface form upon the folds of the drapery.

PLATE 76

Fig. 1

Fig. 2

Fig. 3

PLATE 77.

Fig. 1. Photograph of a woman's skeleton standing with the right arm raised to support a jar as if resting on the head (*from the back*).

Fig. 2. Photograph of a woman in the position of the skeleton in Fig. 1.

Fig. 3. Photograph of the same woman in the same position as in Fig. 2 (with drapery).

PLATE 77

Fig. 1

Fig. 2

Fig. 3

THE INFLUENCE OF THE MUSCLES ON THE SURFACE FORM.

NATURALLY the superficial muscles exert greater influence upon the surface than the deeper-seated ones, especially when the body is at rest; this is true in a less degree when the body is in motion. They are all, however, of importance to the artist-student, who cannot acquire too accurate an impression of the *modus operandi* of the entire muscular system.

In order to understand the rôle the muscles play in the economy of man, it is necessary first to possess some knowledge of their shape, size and attachments, and of their relative bearing to other muscles which are sympathetic or antagonistic to them. For this purpose the author has introduced the series of original drawings designed to demonstrate the attachments of each separate muscle, together with drawings of the entire groups of muscles which are associated in the different regions of the body. The parts of the skeleton which belong to the regions are in every instance drawn to the same scale and based upon photographs from the bones of the well-formed male skeleton (Plate 25). The necessary repetition of the salient features of the bones, it is believed, may serve as emphasis in aiding the memory for future application.

The superficial muscles (Plates 78 and 79) determine the outward form of the entire body, excepting of those parts of the skeleton which are subcutaneous and which are described with the bones. They give breadth and smoothness to the trunk and roundness to the limbs. In the extremities it should be observed that in the fore-arm and hand, and in the leg and foot, the fleshy portions of the muscles occupy the parts nearest to the trunk, and that they generally terminate in long tendons. This arrangement both economizes the contractile tissue of the muscles and conveys their action to greater distances. It also lightens the weight. In every instance

each muscle is adapted in size and form to perform its proper function to the greatest advantage; and, as has been said of the bones, they are so admirably constructed that they defy improvement. The special arrangement of the component fibres of the different muscles is shown in the illustrations, and it is not necessary in this connection to enter into a detailed description.

During life all the muscles are in a state of tension, varying in degree according to the resistance imposed by the weight of the part to which they are attached, the action in which they are engaged, or that in which they are opposing other muscles. The muscles of various groups aid each other in producing a combined result, and all the groups have antagonistic muscles to contend with. It is always the thickest part of a muscle which bulges upon the surface when it is contracted. The tendons do not change in bulk as do the fleshy portions, but are often conspicuous in cord-like elevations which produce surface furrows on either side of them.

As muscular energy varies with the degree of counteraction by an opposing force or in consequence of an effort of the will, it is important to examine into the changes which take place in the contours of the body in certain localities. (Plates 42, 102 and 114 are especially prepared to illustrate this.) The changes on the surface, due to the actions of the muscles, are manifested by their contraction in length and increase in bulk. When the body is standing and resting nearly its whole weight on one limb, the muscles of the leg and thigh of that limb are swelled to a greater degree than those of the other limb, and the swelling occurs about the middle of the leg and thigh. This increase in the girth of the limbs caused by the contraction of the muscles in sustaining the weight of the body is naturally augmented when extra weight is added or an effort of resistance is exerted.

Besides the elevations caused by the various movements of the limbs, there are surface markings due to the muscles which ought to be impressed on the draughtsman. The shape of the neck from behind and from the front always depends on the curve produced by the trapezius muscles as they pass round from the back to their attachments on the collar bones (see Plates 26 and 34); also the swelling on the inner side of the knee

which is produced by the attachment to the patella of the vastus internus muscle (Plate 57), which is always lower than that of the vastus externus muscle and gives rise to the curved outline at this locality whether in action or at rest.

It should be noted that the muscles are generally less developed in the female than in the male. The muscles of the thighs in the female are wider in proportion to their length, and in the fore-arms and legs the fleshy portions of the muscles are relatively longer and their tendons shorter. In the female, also, the muscles of the hands and feet are less pronounced, so that they are both narrower than they are in man.

PLATE 78.

Fig. 1. Photograph of the skeleton of a man (*right side*) to be compared with Fig. 2.

Fig. 2. Diagram of the muscles superposed upon the skeleton as in Fig. 1.

1. The temporal muscle.
2. The occipital muscle.
3. The cervical portion of the trapezius muscle.
4. The trapezius muscle.
5. The triceps muscle.
6. The latissimus dorsi muscle.
7. The gluteus maximus muscle.
8. The fascia lata.

Fig. 2—continued.

9. The biceps femoris muscle.
10. The gastrocnemius muscle.
11. The tendon of Achilles.
12. The frontal muscle.
13. The masseter muscle.
14. The sterno-cleido-mastoid muscle.
15. The deltoid muscle.
16. The pectoralis major muscle.
17. The biceps muscle.
18. The external oblique muscle of the abdomen.
19. The extensor muscles of the fore-arm.
20. The vastus externus muscle.
21. The tibialis anticus muscle.

PLATE 78

Fig. 1

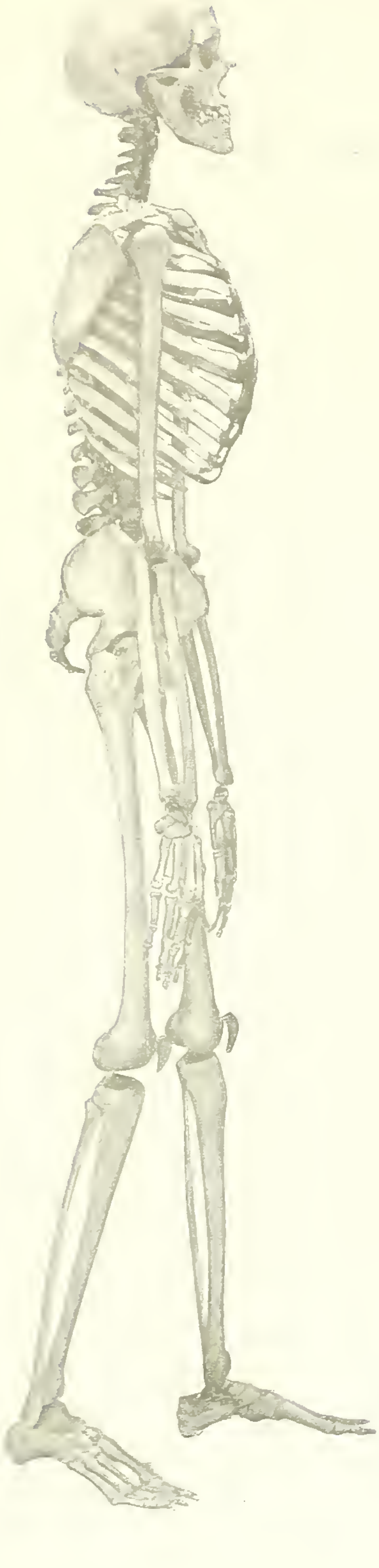


Fig. 2

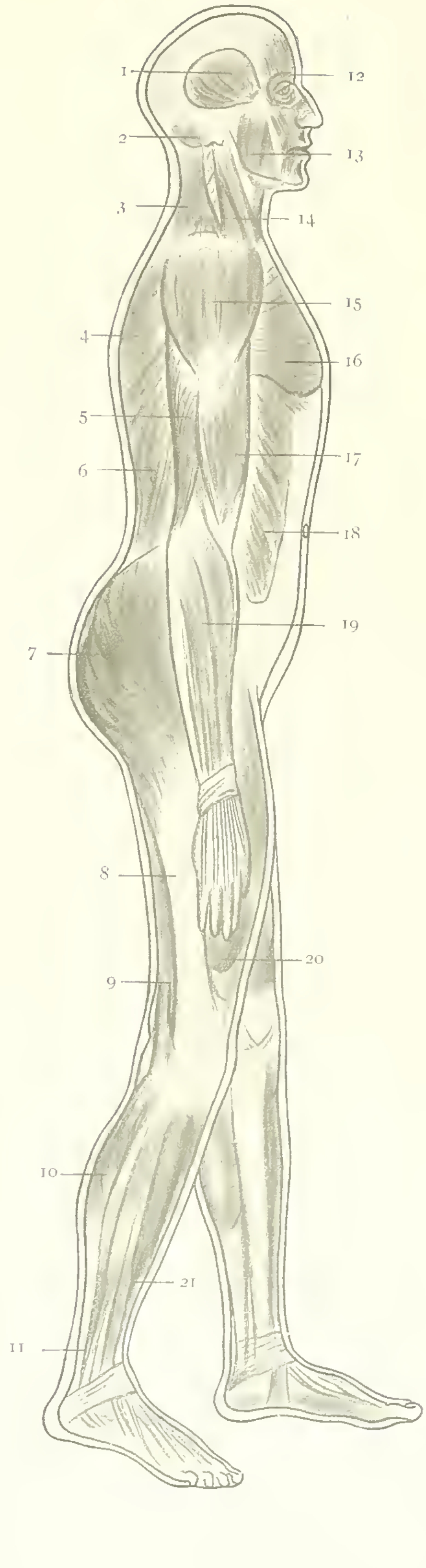


PLATE 79.

Fig. 1. The muscles diagrammatically superposed on the right side of the front of the skeleton.

1. The frontal muscle.
2. The masseter muscle.
3. The sterno-cleido-mastoid muscle.
4. The trapezius muscle.
5. The deltoid muscle.
6. The pectoralis major muscle.
7. The serratus magnus muscle.
8. The biceps muscle.
9. The obliquus externus abdominis muscle.
10. The extensor muscles of the fore-arm.
11. The ligament of Poupart.
12. The gluteus medius muscle.
13. The sartorius muscle.
14. The rectus femoris muscle.
15. The tibialis anticus muscle.

Fig. 2. The muscles diagrammatically superposed on the right side of the back of the skeleton.

1. The occipital muscle.
2. The sterno-cleido-mastoid muscle.
3. The trapezius muscle.
4. The deltoid muscle.
5. The teres major muscle.
6. The latissimus dorsi muscle.
7. The triceps muscle.
8. The external oblique muscle of the abdomen.
9. The gluteus maximus muscle.
10. The semi-membranosus muscle.
11. The biceps femoris muscle.
12. The gastrocnemius muscle.
13. The tendon of Achilles.

PLATE 79

Fig. 1

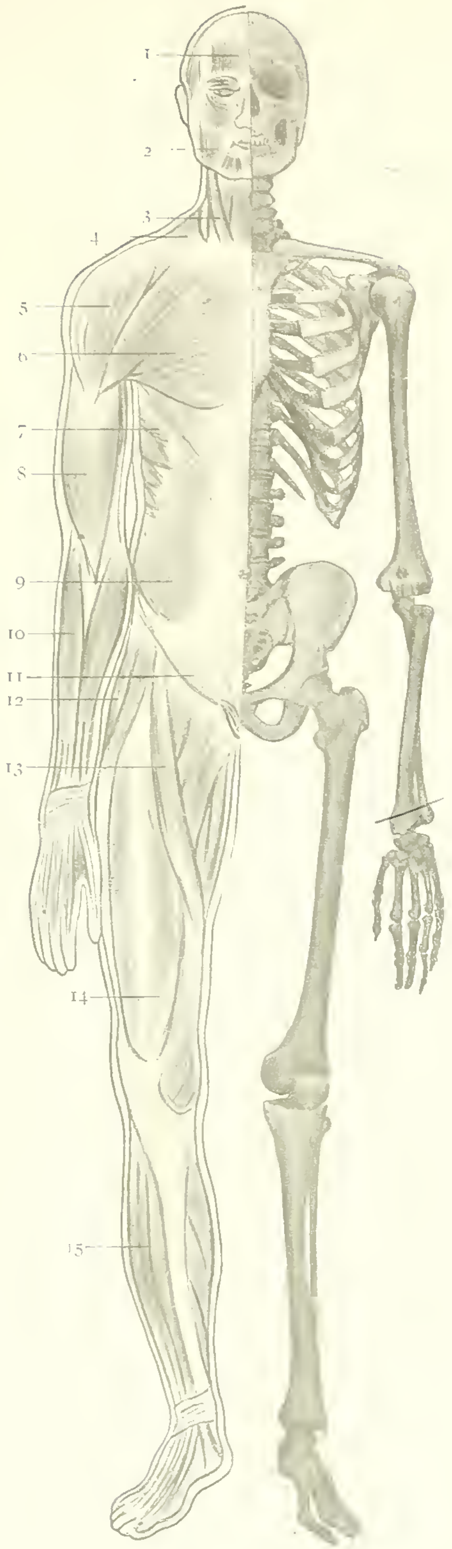


Fig. 2

PLATE 80.

Copy of an engraving adapted from a statue of Hercules and Antaeus.

It is represented as if the skin had been removed to show the superficial muscles in action. This plate originally appeared in "Cheselden's Anatomy of the Human Body," published in 1758.

The well-known fable that Antæus every time he touched his mother earth had his strength renewed, is finely illustrated in this group which represents Hercules raising him on high so as to crush him in his arms. The chief value of this illustration is the contrast between the powerful muscles of the back and arms of Hercules and his gigantic legs set widely apart compared to the powerlessness of the limbs of Antæus, which not only show that the source of his strength has been cut off but that his vital power is being crushed out of him by the pressure of his adversary.

PLATE 80

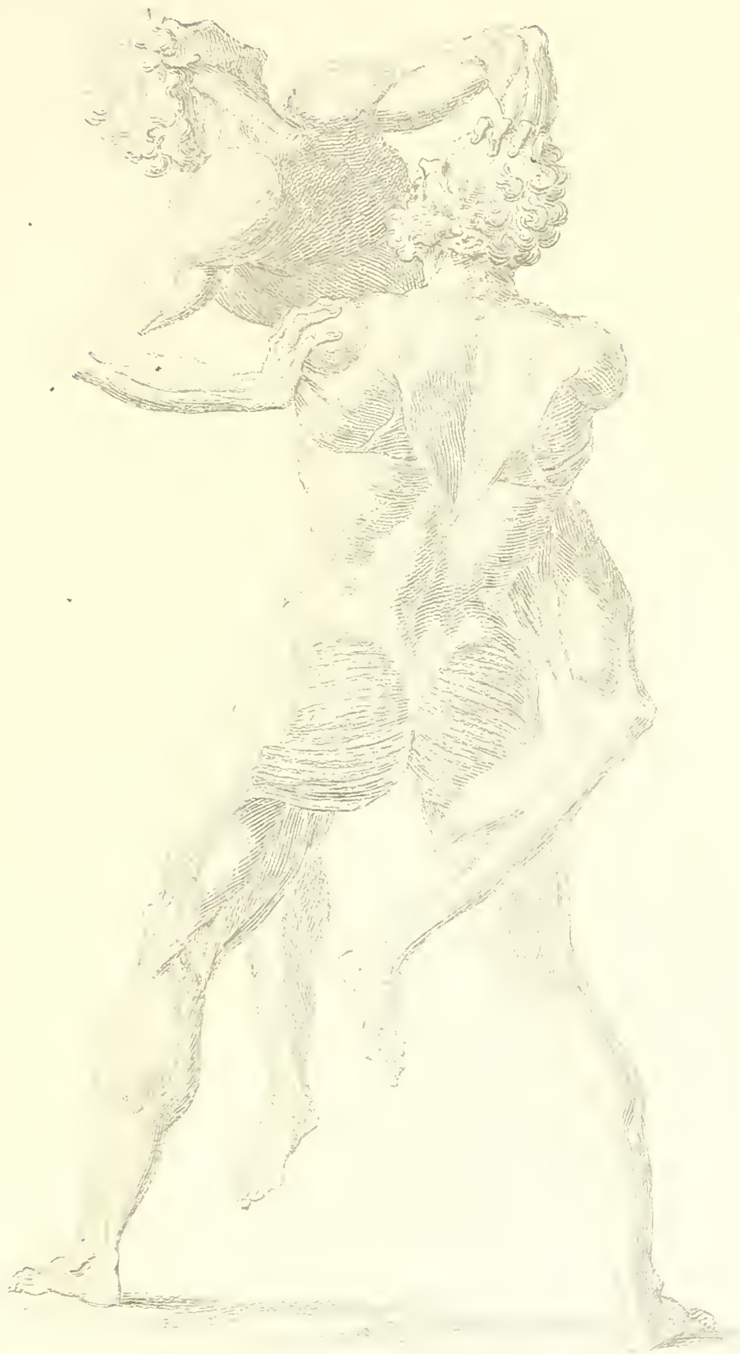


PLATE 81.

Photograph of a model dressed in a tight-fitting elastic suit, upon which the superficial muscles and their tendons have been painted as they would be seen if the skin were removed.

This suit, the purpose of which is to show the relative position of the muscles in any attitude, has been in use for class demonstration since 1885.

PLATE 81

THE ATTITUDES AND POSTURES.

THE *attitudes* of the human body are those positions which represent arrested motion. They are infinitely varied, partaking of the very essence of movement, from the delicate poise of the dancing figure to the fierce recoil of the warrior in battle or of the pugilist before striking a decisive blow.

The *postures* are the different positions which the body assumes when it is in repose. They are the standing or upright, the sitting, the kneeling, and the recumbent positions. In considering the postures it is necessary to remember that the centre of gravity is the chief condition by which the body is able to maintain its equilibrium.

In the *upright posture* the centre of gravity, which is found to be about the second sacral vertebra, passes to the plain of support which is limited by the separation of the feet. The wider this plain the more assured is the upright posture. The posture of a soldier at rest with the heels in contact is more fatiguing than the ordinary standing position with the heels apart. In the one the base of support is triangular; in the other it is quadrilateral.

When a man supports a burden in the upright position he is obliged to incline in different ways owing to the additional weight to that of his body. The centre of gravity always passing between the feet. If he carries a burden on his back he leans forward, or backward if he supports the burden in front. Thin people for similar reasons often bend forward, and fat people bend backward. If the additional weight be carried in one hand he leans toward the opposite side and stretches out the other arm.

The exact adjustment of the position of the centre of gravity is not all-sufficient to maintain the body in the upright posture, and it is necessary that the muscles should contract so as to immobilize the joints of the trunk and the lower limbs. Without this power of contracting of the muscles, the subtleness of the joints would enable them to bend in varying directions and would cause the body to fall in a helpless heap.

The muscles which serve to maintain the equilibrium of the body upon its base of support are the *extensor* muscles. The muscles of the calves of the legs prevent the flexion of the feet, and the extensor quadriceps on the front of the thigh opposes the hamstrings at the knee, and the muscles of the buttocks, with the assistance of the erector spinæ mass of muscles, prevent the pelvis and the vertebral column from flexing forward. This is all done through the influence of the will. One who becomes unconscious can no longer support himself.

The continuous active contraction of so many muscles becomes fatiguing when unduly prolonged, and, therefore, the difficulty of maintaining the vertical posture for a length of time.

The *sitting posture* is that position in which the body is supported upon the two ischial tuberosities of the pelvis. In this posture the body tends to fall backward because the two ischii are in front of the centre of gravity. In consequence of this backed chairs were introduced to afford comfort to the body in sitting. When sitting upon a stool or chair without a back the body is naturally inclined forward so that the line of gravity may pass through the base of support with the feet resting on the ground.

The squatting position assumed by Orientals is more endurable than sitting, because the base of support is broadened by the space between the two ischii and the outer borders of the feet.

Kneeling is the position assumed when the weight of the body is supported on the patellæ, between which the line of gravity passes. This position soon becomes wearisome owing to the base of support being limited, and to the delicacy of the skin over the knees which sustain the weight. The fatigue of this position may be diminished by leaning the body forward against some object, or backward upon the heels.

The sitting and kneeling posture, as well as the erect, require the active co-operation of the muscular system with the natural tendency exerted by the centre of gravity to maintain them, but in a less degree.

The *recumbent position* differs from the other postures essentially, because, in the absence of the muscular action for support, the body is abandoned to its weight. This posture is naturally that of rest, as it is the only one in which there may be absolute relaxation of muscular effort, the base of support being co-equal to the length of the body supported.

Lying upon the back is the most favorable position for respiration, and on this account is assumed in infancy and old age. The body may find repose upon the back or upon either side.

PLATE 82.

Photograph of a woman model standing with the weight chiefly supported on the right foot, and the arms raised showing the graceful outline of the waist and hips (*from the front*).

PLATE 83.

Photograph of a woman model standing in an easy attitude, showing the curves of the neck, back and loins.

PLATE 82

PLATE 83

PLATE 84.

Photograph of a woman in a position suggested by the posture of Venus, in a group of "Venus and Cupid," by Thorwaldsen.

PLATE 85.

Photograph of a woman in the attitude of one who is about to draw water from a well.

PLATE 84

PLATE 85

PLATE 86.

Photograph of a woman in the attitude of advancing and holding out her hand in greeting.

PLATE 87.

Photograph of a woman with the arms raised as if arranging clothes on a line to dry.

N. B.—These plates are intended to show the play of the muscles of the female figure in ordinary every day action.

PLATE 86

PLATE 87

PLATE 88.

Photographs of a woman dancing, in three different postures, to illustrate varied motions of feet and hands in balancing and maintaining poise in graceful action.

PLATE 89.

Photograph of a cast from the statue, "L'ecorche," in the position of an orator, by the French sculptor, Jean-Antoine Houdon, 1771, which is admirably suited for demonstrating the superficial muscles (*from the front*).

PLATE 90.

Photograph of a man in approximately the same position as in Plate 89.

PLATE 91.

Photograph of Houdon's statue (*from the right side*).

PLATE 92.

Photograph of a man in the same position as in Plate 91.

PLATE 93.

Photograph of Houdon's statue (*from the left side*).

PLATE 94.

Photograph of a man in the same position as in Plate 93.

PLATE 89

PLATE 90

PLATE 91

PLATE 92

PLATE 93

PLATE 94

PLATE 95.

Fig. 1. Photograph from a cast of a statue of an athlete, called "The Sandal Binder," now in the Louvre at Paris.

Fig. 2. Photograph of a man in the same position as the statue in Fig. 1.

N. B.—These photographs were taken on the same negative.

PLATE 95

Fig. 1

Fig. 2

PLATE 96.

Photograph of a statue called "Mercury Resting."

This is considered one of the most perfect of the antique bronze statues and is now in the museum at Naples. It was discovered at Herculaneum, and is supposed to be the work of Lycippus (450 B. C.). It admirably exhibits the effect of suspended muscular energy of a young man in repose after the effort attending rapid exercise.

PLATE 97.

Photograph of a man in approximately the same position as shown in the bronze statue in Plate 96.

PLATE 96

PLATE 97

PLATE 98.

Photograph from a cast of the statue called "Diskobolos," in the Vatican at Rome.

It is attributed to Naucydes (440 B. C.). It is a remarkable example of the careful study given to the harmonious development of the body by the ancients. The attitude suggests the repose of conscious power, while the face denotes the absorption of the disk thrower in determining the exact force and direction with which he is about to give impetus to his missive.

PLATE 99.

Photograph of a man in the same position as the statue in Plate 98.

PLATE 98

PLATE 99

PLATE 100.

Photograph from the cast of a statue of "Diskobolos," now in the Palazzo-Messini at Rome.

It is attributed to Myron (450 B. C.). It is remarkable for its illustration of the effect upon the surface form at a moment of rapid action. The body is represented in violent exertion and exhibits the graceful precision due to training. The energy of both body and mind are concentrated on one movement.

PLATE 101.

Photograph of a man in the same position as the statue in Plate 100.

PLATE 100

PLATE 101

PLATE 102.

Photograph of a man carrying in his right hand a weight of fifty pounds, while he holds with his left hand a slender cord and pendulum between the forefinger and thumb.

The study of these contrasted effects is instructive and should be noted in detail. First, the swelling of the muscles of the calf of the right leg and the group of extensor muscles on the front of the right thigh resulting from the weight being chiefly sustained on that limb, is to be contrasted with the relaxed state of the left limb, where the fascia lata over the extensor muscles of the thigh presents a graceful curve, and the tendon of Achilles is alone contracted in raising the heel so that the toes of the left foot rest upon the ground.

This position of the left limb relieves, however, part of the tension of the right limb, which chiefly sustains the weight.

The changes exerted at the shoulders by the different degrees of actions of the deltoid muscles are also marked. The effect on the right upper limb is to accentuate the swelling of the deltoid and that of the biceps muscles, while the flexor muscles of the fore-arm are hardened into a strong mass to resist the weight sustained by the hand, and the extensor muscles are tensely drawn with the effort to counteract them. On the left shoulder the deltoid muscle draws the pectoral muscle into strong relief in raising the arm to a right angle, while the biceps muscle is contracted in the same action and the triceps muscle hangs loosely from the arm-pit to the elbow.

PLATE 102

PLATE 103.

Fig. 1. Photograph of the skeleton of a man in approximately the same position as the man in Fig. 2.

Fig. 2. Photograph of a man whose weight is supported on the left limb with the right hand extended, as in a gesture of explanation, and the left fore-arm and hand bent back on the chest, as if holding the folds of a cloak or toga.

Fig. 3. Photograph of a man in the same position as in Fig. 2 (with drapery).

The ease and lightness of the whole attitude are to be contrasted with the enforced precision of the left upper limb (Plate 102) and the constrained effort of the right upper limb which sustains the weight in that plate. The centre of gravity falls in the same perpendicular line as in the former plate, from the neck to the left heel, but the right knee is advanced and thereby throws the left thigh into less marked relief than the right thigh in Plate 102. The right foot resting slightly on the toes gives the effect of momentary poise or attitude ready to be changed for another at will, and conveys no impression of any exertion in the figure to support itself.

PLATE 103

Fig. 1

Fig. 2

Fig. 3

THE MOVEMENTS OF PROGRESSION

WALKING, or the ordinary means of progression, consists of successive actions called *steps*. An analysis of the changes of position which affect the trunk and the lower limbs at every step, shows that there are two principal movements in which each step is executed. In the first movement the body rests upon the two lower limbs, and in the second it only rests upon one or the other. Upon each new step the leg which supports the body in the second movement is carried forward by an oscillatory action which may be compared to the swing of a pendulum. During the walk the body is carried alternately to the right and to the left, first upon one leg and then the other, so that the individual progresses by a series of movements of oblique projection which succeed each other more or less rapidly. There results a peculiar swinging which is accentuated according to the separation of the feet and the width of the hips. This is characteristic of the walk of sailors, called their "sea legs."

With unconscious effort to balance the movements of the limbs in walking, the arms naturally swing in opposite directions to the corresponding legs, performing oscillations inversely to them. When one leg is moved from behind forward the arm of the corresponding side moves from before backward. Fatigue in walking comes on more quickly when the hands are kept in the pockets or the arms are folded. The impulsion in walking is strongest on the right side, as can be demonstrated by placing a blindfolded man upon the middle of a square, when it will be noticed that he invariably moves toward the left. Directness in walking, therefore, depends upon the integrity of the sight.

Walking up hill or up stairs (Plate 104) is more difficult than walking upon level ground, because at each step the muscles of the lower limbs have to lift up the body to follow an ascending line parallel to the inclination of the ascent. In this upward effort of the lower limbs the extensor muscles

of the thighs are brought into very active use and the chief strain is borne upon the knees.

In walking down hill or down stairs (Plate 105) the contraction of the muscles tends to prevent the trunk from falling forward, and this strain is chiefly felt at the loins.

The action in *jumping or leaping* differs from that in walking, inasmuch that at a given moment the body is entirely off the ground, and is projected more or less suddenly backward or forward by the absolute extension of the lower limbs and by the flexion of the spine to one side or the other.

The extent of the leap is greatest when the lower limbs are very long. This is seen in the case of all the lower animals, from the frog to the hare or kangaroo, etc., wherever the hind legs are more developed than the fore legs.

In jumping the impetus is increased by swinging the arms, and it may be further increased by preceding the jump by running.

Running (Plate 73) consists of a progression which is composed of a succession of rapid jumps, and the muscular contractions are more numerous and stronger than in walking. The muscles employed are the same.

Swimming is a series of horizontal leaps taken in the water. The impulse which pushes the body forward results from methodical movements of the upper and lower limbs.

While the definition just given of muscular actions involved in movement is original, the synopsis of conditions in the relation of the different postures to the centre of gravity is adapted from G. Witkowski, whose work on the "Structure and Functions of the Human Body" first interested the author in popularizing the study of anatomy.

PLATE 104.

Photograph of a man walking up stairs taken at the moment that he is leaning forward so as to place his weight upon the upper step.

The curve at the back should be especially noticed as indicative of the ascending impulse of the whole body.

PLATE 105.

Photograph of a man walking up stairs with the knee more bent than in Plate 104, and the limb which is extended in the act of leaving the ground, turned toward the camera.

The movement in this instance is more deliberate than in Plate 104, and the upper portion of the body is entirely passive.

PLATE 106.

Photograph of a man walking up stairs in exact profile.

The step here is higher than in the two previous plates and the effort to mount more apparent, while the weight is more evenly distributed between the upper and lower steps.

PLATE 107.

Photograph of a man stepping downward.

The chief contrast between this and the plates showing the man stepping upward, is the relaxation of effort, illustrated, not only in the comparative repose of the lower limbs, but curiously shown in the manner in which the arms and hands hang at ease by his sides.

PLATE 104

PLATE 105

PLATE 106

PLATE 107

PLATE 108.

Instantaneous photograph of a woman running rapidly toward the camera with the arms outstretched.

It will be noticed that the whole weight is sustained on the right foot, and the body so far thrown forward that only the toes are resting on the ground. The rapidity of the motion may be measured by the distance to be traversed by the left foot before reaching the ground.

PLATE 108

PLATE 109.

Photograph of the famous bronze statue of "The Flying Mercury" by John of Bologna (A. D. 1524) at Florence (*right side*).

PLATE 110.

Photograph of a model in approximately the same position as the statue of "The Flying Mercury" in Plate 109.

The man thus represented was poised upon the ball of the left foot, the whole weight of the body thrown forward, and the right arm raised as though pointing upward. The play of muscles thus displayed upon the shoulders and back is unusually fine. Attention should be especially drawn to the fold of integument of the neck caused by the turn of the head over the right shoulder, and to the modelling of the muscles of the loins and hips of the right limb, which is extended backward.

PLATE 111.

Photograph of the bronze statue of "The Flying Mercury" by John of Bologna (*left side*).

PLATE 112.

Photograph of a model in the same attitude as the statue in Plate 111 (*left side*).

The most instructive feature of this photograph is the effect of the action of the diaphragm on the outline of the chest and abdomen. This action is manifested by the contraction at the enciform cartilage, where the recti muscles are attached, and the indrawing of the upper lateral abdominal walls. This is accompanied by the expansion of the chest that follows on the upward movement of the arches of the diaphragm (page 58) as a consequence of violent effort.

PLATE 113.

Photograph from a cast of the famous statue "The Fighting Gladiator," by the Greek Sculptor Agasius, brought from the Villa Borghese, Rome, by Napoleon, to Paris, and now in the Louvre (*from the front*).

PLATE 114.

Photograph of a man in approximately the same position as the statue in Plate 113.

N. B.—While this model is not so muscularly developed as that from which the statue was made, yet the outline and surface markings are suggestive of the energy of the body in this posture.

PLATE 115.

Photograph from a cast of the statue of "The Fighting Gladiator" (*from the back*).

PLATE 116.

Photograph of a man in approximately the same position as the statue in Plate 115.

PLATE 113

PLATE 114

PLATE 115

PLATE 116

THE PROPORTIONS OF THE HUMAN FIGURE.

ALL measurements and so-called rules of proportion of the human figure can only be capable of limited application. They are often so complicated that they lead to erroneous conclusions. The height, breadth, and general conformation, are due, it is true, to the development of the skeleton, but the bulk of the form and the contour of the limbs, so important in producing the effect of beauty, depend upon the general healthy nutrition of the body, leading to a normal formation of fat in the tissues, which masks the undue prominence of the muscles, without detracting from the effect of muscular energy.

What artists need is judgment of the harmonious proportions of the several parts of the body in relation to one another, whether their conception be of the real or of the ideal form. This judgment can best be acquired from anatomical knowledge, which will explain the purposes of construction of the body.

The framework of each normal individual is constructed upon the principle of fitness of means toward an end, or of that individual as an entity. A long arm is useful in boxing or in wielding a hammer, but it would not suggest ready adaptation to lighter work. A long narrow head and slender hands and feet are not furnished by nature to a short, broad trunk.

A perfectly formed man or woman is almost as rare as the honest individual who has long been counted among the noblest works of the Creator! In other words, the proper development of the entire body, or what is understood to be the harmonious relation in size and shape of its component parts, is exceptional. Often when the upper portion approaches the standard, the lower portion is defective, or vice versa.

The proper relative length of the several parts of the body can be determined by measurement. To this end it is well that artists should have some definite scheme by which to draw the size of the figure correctly, but such a scheme can only enable them to construct the mechanical proportions of the body. Grace, symmetry, and harmony, upon which the beauty of the outward form depend, cannot be defined by any rule or formula. Observa-

tion, combined with a knowledge of the anatomy beneath the surface, will result in producing the proper shape of the parts as well as the whole.

Examination of most of the antique statues will prove that the effect of harmony in their proportions is not due so much to the relative measurements of the head, limbs and trunk, as to the careful exhibition of the surface forms resulting in each case from the most intelligent study of life in repose or in action.

It is this observance of nature which gives to the ancient sculptors the just title of "Masters in Art."

Thorwaldsen, of all modern sculptors, excelled in his work through his comprehension of the facts relating to the outward form, and all his statues bear evidence to his power of distinguishing and fixing the varied types of human strength or beauty, and to his close attention to proportion, based upon a knowledge of anatomy. Whereas it is certainly possible for some who have natural powers of observation, exercised almost unconsciously, to convey their impressions with the brush or chisel, so as to produce an agreeable result, without examining into the causes of the effect which they have received and transmitted, yet this gift is rare. To the many who do not possess it, rules of proportion, however imperfect, are necessary.

The scheme for arriving at the correct dimensions of the human figure, which the author recommends, is based upon the supposition that the most perfect form of man should measure as to length, eight times the length of the head; and of woman, seven and one-half. (Plates 118 and 119.)

Using the head-length (*i. e.*, the skull-length) as a unit for measurement, as demonstrated in Plate 117, the following simple table of reference can be deduced, which does not require taxing either the memory or the imagination:

In Man in the erect position.

The width between the shoulders should equal the length of two heads.

The width between the hips should equal the length of one and one-half heads.

The width between the nipples should equal the length of one head.

The Upper Extremity should measure three heads.

The distance from the point of the shoulder to the point of the elbow should equal the length of one and one-quarter heads.

The distance from the point of the elbow to the knuckle of the middle finger should also equal the length of one and one-quarter heads.

The length of the middle finger should be a half a head length.

The Lower Extremity should measure four heads.

The distance from the great trochanter of the hip to the bottom of the patella should equal the length of two heads.

The distance from the bottom of the patella to the sole of the foot should also equal the length of two heads.

The trunk should measure two and one-half heads in length.

In Woman in the erect position.

The width between the shoulders should equal the width between the hips, and this should be equal to the length of one and three-quarter heads.

The width between the nipples must vary, according to age and the development of the breasts.

In woman both the upper and lower extremities are comparatively shorter than they are in man; but their respective measurements from point to point, as given for the man, are the same; *i. e.*, from the point of the shoulder to the point of the elbow should equal the distance from the point of the elbow to the knuckle of the middle finger, and from the great trochanter to the bottom of the patella should equal the distance from the bottom of the patella to the sole of the foot.

The trunk is approximately the same in both man and woman, there being little difference when sitting. The difference in height is chiefly owing to the greater length of the lower extremities in man.

The measurements here given are the result of very careful examination of many skeletons and of numerous living models.

They are based upon the Greek scale of Vitruvius, which was adopted long ago by Leonardo da Vinci, as shown by a famous diagram that he made, but the author has taken pains to verify them by his own observation. Since the time of da Vinci many writers on the subject of proportions have striven to demonstrate that his measurements were not correct, and have based their assertions upon scientific facts. They have deduced from an average of specimens of the different human races what is called the anthropometric scale. This, like all scientific averages, is the mean adopted after comparative examinations of all sorts of specimens of the different races, and it is not to be considered in relation to the requirements of art. Anatomy is not artistic, it is rather scientific; but as it is the only means of arriving at a knowledge of the construction of the human body, it is the best method of reaching the fundamental principles of proportion, which should be understood to be the harmonious development in size and shape of the component parts of any body in relation to one another. Artists should never lose sight of these facts, or forget to distinguish them through the modifying influences of habits and age.

It is to be borne in mind, from an artistic point of view, the goal is perfection, and few human beings ever reach the standard. The man whose figure has been so frequently represented in the illustrations of this book is a remarkable instance of harmonious development, although his hands and feet are not finely shaped. The different poses and attitudes assumed by him in Plates 90, 92, 94, 97, 99, 103, 110 and 112 show the rare degree of beauty of his figure. Examination of the photographs of this model side by side with casts of many of the antique statues, will afford valuable suggestions to the sculptor, and it may be noticed how well the model bears the comparison.

The photographs of the female figure used in illustration of a number of womanly positions, chosen with a view to the display of muscular action or repose in the ordinary vocations of life, are much simpler than those of the male figure, because it is not common for artists to desire to depict a woman's form in athletic excercises or under the stress of hard labor.

The model who posed for these studies was chiefly remarkable for beauty of outline at rest or in motion, but it should be noted that the

generally fine proportion of her figure is impaired by a lack of maturity in the development of the breasts. Her grace of form is perhaps more noticeable in repose, as in Plates 75, 76, 77, 82, 83, 84 and 85 than in some of the dancing figures (Plate 88) which complete the series.

Such defects as may be found in different models will only go to prove the rule, if it be borne in mind that the goal is perfection. The effect produceable by changing the measurements in drawings was often essayed by the ancient artists, whose opportunities for studying the naked body gave them the advantage of becoming familiar with its contour and proportions. The head was sometimes shortened to produce the effect of youth, or the limbs lengthened to suggest grace and freedom of action. Strength and power were naturally indicated by increase of muscular development.

The author has always considered it injurious to allow students to dwell too much, however, on the subject of excess of muscular development, for it is apt to give an exaggerated impression, which is very far from a truthful one.

Few men ever exhibit their muscles on the surface in the ordinary actions of the body; women never do. The over-developed man who is considered as a Hercules is only fit for study in contrast with a model whose muscles are not prominent in repose and only show the swelling on the surface when brought violently into play. It is well to recognize that the muscles are there, and to know what they are capable of doing, but it is not well to indicate them in such a way as to give them unnatural emphasis. Truth is what should be aimed at, and what is excessive in development should not be substituted in the effort to convey reality of impression.

It is wise in painting and sculpture, as in all the other arts, to avoid extreme effects.

PLATE 117.

Photograph of a man in the erect position with arms equally extended on either side. The squares and circle were drawn on the photograph to show the admirable proportion of this man's figure. The measurement from the top of his head to the soles of his feet is the same as the measurement from the finger tips of one hand to those of the other, i. e. exactly eight times the length of his head, and as his head measures eight and one-half inches, his height is exactly sixty-eight inches or five feet eight inches.

This man's figure also demonstrates the scheme for proportion on page 130. Compare Plates 90, 92, 94, 99 and 110.

N. B.—The circle is merely drawn on this Plate to show that the square is a perfect one.

PLATE 117

PLATE 118.

Photographs of a man, from the front and left side, with transverse parallel lines superposed to demonstrate the division of the stature into eight head lengths (see page 130). Compare Plates 1 and 5.

PLATE 118

Fig. 1

Fig. 2

PLATE 119.

Photographs of a woman, from the front and left side, with transverse parallel lines superposed to demonstrate the division of the stature into seven and one-half head lengths (see page 130). Compare Plates 3 and 5.

Fig. 1

Fig. 2

PLATE 120.

Fig. 1. Photograph of a man (*from the back*) with transverse parallel lines superposed to demonstrate the division of the stature into eight head lengths (see page 130). Compare Plates 1 and 5.

Fig. 2. Photograph of a woman (*from the back*) with transverse parallel lines superposed to demonstrate the division of the stature into seven and one-half head lengths (see page 130). Compare Plates 3 and 5.

PLATE 120

Fig. 1

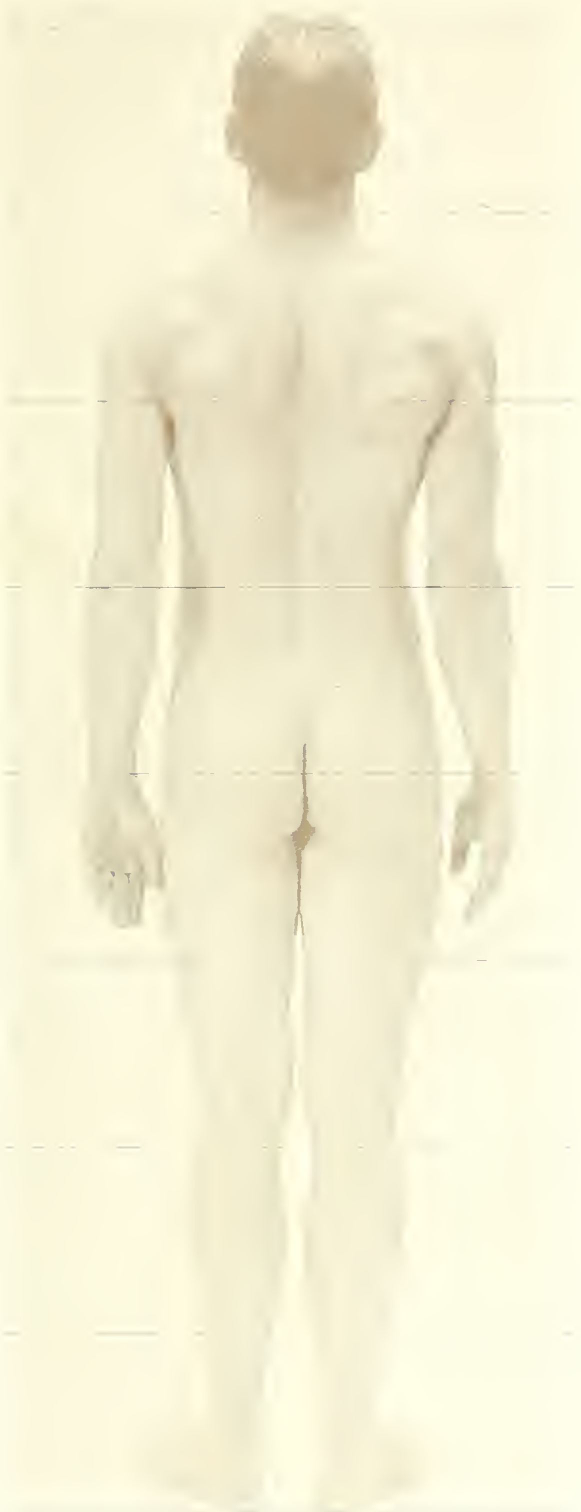


Fig. 2

PLATE 121.

Photograph of a girl baby, seven months old, showing the furrows on the front of the thighs before the lower limbs are able to support the weight of the body.

This plate is especially interesting in this connection because it represents a perfectly developed child, which is almost as rare as is the adult (page 129). It should be noted that the length of the figure is about four and a half times the length of the child's head, which corresponds to the accepted rule of proportion at this age.

N. B.—The negative from which this plate was taken was originally made, with a series of others, by the author for the illustrations of his work on the Anatomy of Children, 1889.

PLATES 122, 123, 124 and 125.

Plates 122 and 124 are from photographs taken at Paris, by the author, in 1893, by special permission of the superintendent of the Louvre.

They are from a cartoon by David (1789). It represents a moment of supreme patriotism, when all the members of the French Assembly, of divers opinions and different professions, coming from various parts of the country, met in the tennis court at Versailles and took the oath of allegiance to the first Republican Government, in which they believed they were pledging themselves to uphold freedom. This sketch is called, "Le Serment du Jeu de Paume."

Louis David, one of the best known and remarkable painters of the time of the French Revolution, was a politician as well as an artist and knew personally most of the principal actors in this drama, so that he collected in the foreground of his picture, groups of portraits of many of the most conspicuous men, who joined in taking the oath in striking contrast to one another.

Plates 123 and 125 are also from photographs of the completed picture of which plates 122 and 124 represent the cartoon.

Plate 123 shows Mirabeau, Dubois Cranèe and Robespierre; Plate 125 shows Gert (a Carthusian monk), Rohan St Ètienne (a Protestant minister), and the Abbè Gregoire (a Catholic priest).

It will be noticed that the figures in the cartoon are approximately of the same height, and critics, who might have been better employed, in studying the fitness and perfection and proportion of each individual figure, have carped at this seeming want of attention to the laws of perspective. What chiefly concerns this work is the naturalness and the absolute unconscious abandonment of each attitude or posture to the spirit of the moment, resulting from very careful attention to the anatomical relations which are worked out to such a degree of perfection in the preliminary study, that even had they been covered by clothing as in the finished picture, they might still be recognized and distinguished.

It is evident that David began the cartoon with enthusiasm, as shown by the cleverness and admirable technical work on the heads and hands of most of the figures.

The cartoon itself is all that David's own hands accomplished. The finished picture was the work of Moreau, one of his pupils, and is now at the museum at Versailles. While it is unquestionably based upon the original sketch by David, the latter in its unfinished state may justly be considered superior.

It was long the custom among the old Italian school of artists in their composition studies for statuary or painting, to make a preliminary sketch of the figures they wished to represent, in the nude, indicating, with more or less precision, the prominences of the skeleton or the action of various muscles which were indicative of the character of the form which they intended to represent. No modern artist seems to have appreciated the value of this method more than David, who, in his compositions, first drew the naked figure in order to give the natural movements under the garments with which he covered them later, so that the drapery was thus subordinated to and harmonized with the action or posture.

In illustration of this principal these photographs are here included. As studies of the application of Anatomy to Art, they are certainly worthy of close attention and of careful comparison.

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